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NEW YORK, OCTOBER, 1895.

ANNOUNCEMENT.

AFTER November 1 the AMERICAN ENGINEER will be published bi-weekly, and will appear every alternate Thursday. Each number will contain one-half as much reading matter as is now given in the monthly issue. The price, per number, will be reduced to 10 cents, and the annual subscription to subscribers in this country, Canada and Mexico to $2.50. Owing to the additional postage the rate to foreign subscribers will remain $3.50. Some changes, which it is hoped will be improvements, in the scope and character of the paper will be made, and will be announced later. It is also thought that the more frequent publication will enable us to keep more closely in touch with current events and the advancement of engineering art and science, and that the change will materially increase the interest of the paper to our readers and its value to our advertisers.

EDITORIAL NOTES.

HAVING carried on extensive experiments with armor-piercing shot, and learned the ratios existing between the penetrating properties of the shot and the resisting properties of the armor, the authorities at Indian Head are extending their investigations still further, and are now searching for the probable results to the framing of the ship should a shot penetrate to the interior. The first experiments are said to have proven that the framing is up to all of the requirements that can be expected of it, in that it will probably not be entirely annihilated by a penetrating shot. Still it is difficult to conceive how it would be possible for a 13-in. shell, for example, to enter the confined limits of the interior of a turret and not carry such devastation with it that the guns and men would be practically swept out of existence. This position seems to be corroborated by the reports that have reached us of the conditions existing on board the Chinese vessels during the Yaloo fight, where the crew seem to have been almost crippled by the heat, noise, and concussion, to say nothing of the entering shot. Still it is to be hoped that the Indian Head experiments will be carried to such a point that we may know just what to expect from the impingement on or penetration through a turret armor by a heavy shot.

IT is somewhat amusing to note the excitement, either actual or assumed, that the Baldwin-Westinghouse coalition announced in our last issue has created. It has been heralded as the knell of the locomotive and the victorious triumph of the electric motor; whereas it is a straight business arrangement wherein two great establishments agree to work together for a mutual advantage. The death of the locomotive and the survival of the electric motor in its place is not expected in the immediate future by those who are leaders in the construction or development of either. Each has a field of its own that the other cannot fill. For years locomotives were advertised as suitable for and as especially adapted to street railway work; yet we do not know of a single line through a city street that was operated by them, despite all the pushing that they received, though there were a few lines on the outskirts that were so operated. Yet within the short space of eight years the electric motor has swept the locomotive from every claim to suitability for this work. It has its place that the locomotive cannot fill, but until the conditions of efficiency, operation, and traffic are vastly different from those now prevailing, no electrician of repute will consider that the knell of the locomotive has been sounded.

MONTHLY MEETINGS OF MECHANICAL ENGINEERS.

INQUIRIES are beginning to be made whether those members of the Society of Mechanical Engineers who have an inclination to meet together, in New York, once a month, for the discussion of subjects in which they are all interested, are to have that privilege during the coming winter. As is well known, there has been opposition from certain quarters to the holding of such meetings, on the ground that they would be the cause of dissatisfaction among the non-resident members who cannot have a part in them, and the opponents would not consent to the holding of such conferences, as meetings of the Society, and therefore they have always been designated as meetings of *members* of the Society—which reminds us of a little story. During the war a sentimental young woman visited one of the army hospitals, and seeing a good-looking soldier among the sick, inquired of him whether she should bathe his fevered brow. "You may," he replied, "if it will do you any good, but you will be the fifteenth woman who has done it to-day."

Now if it does the opponents of these monthly meetings any good to call them meetings of *members* instead of meetings of the Society, the concession will be harmless, and it may be a comfort in some way to them. As a matter of fact, the objection which has been made is a purely imaginary one, and seems to exist, not among the non-residents, but only in the minds of a few New York resident members who prefer social to technical meetings and ice-cream to engineering. To all intents and purposes the meetings have been meetings of the Society, and therefore they ought to be conducted by the Council, either directly or through a committee. During the two years

that they have been held they have been very successful, and it is certain that if they are not continued it will be a cause of regret to many members to whom they have been a source of edification and enjoyment. It is moved that they be continued during the coming autumn, winter, and spring. Who will second the motion?

RAILLERY.

SINCE the last number of the AMERICAN ENGINEER went to press the technical and the daily papers in this country and in Europe have given much space to accounts and comments on the railroad contest in England and Scotland. It is hardly worth while now to attempt to give detailed accounts of this race, as it has been called. All that we need to say is that there are two lines from London, leading northward into Scotland, the terminus of both being Aberdeen. The general location of these being somewhat like that of two brackets placed thus (), the one on the right touches the east coast of the island, and the other the west coast. The distance from London to Aberdeen, by the East Coast line, is 523½ miles, and by the West Coast, 539¼ miles. These lines compete for business, and as a result of this competition the companies interested attempted to show which of them could run their trains in the shortest time. That it is not easy at this distance to know exactly what the results of thi trial of speed were, is indicated by the remarks of a correspondent of the London *Engineer*, who has written an interesting account of the "race," and who says that "it may be observed that there is the greatest difficulty in obtaining trustworthy records of the actual times of the trains. It was obviously impossible for one man to go by all trains of both routes, and so recourse must be had to official records or passengers' timing. Unfortunately these disagree among themselves in many important subjects."

As nearly as we can make out from the published reports received at the present date, the quickest time made on the East Coast was 523½ miles in 520 minutes, including stops, or an average of 60.44 miles per hour. On the West Coast the run of 539¼ miles was made in 518 minutes, including stops, or 62.52 miles per hour.

Commenting on this, *The Engineer* says—and hence the title of our article: "One gratifying result of the race will be *perhaps** to silence the boasting of the American press. The far-famed Empire State Express has been thoroughly beaten. No engineer in this country, and probably very few in the United States, believes that a mile was once run on the New York Central in 32 seconds, or that 5 miles have been run in three minutes. Concerning long-distance runs, however, there is not room for doubt, an inaccuracy of a few seconds in timing being of no importance. It is said that the 'record run'† of the United States was from New York to East Buffalo, 439.5 miles, in 425 minutes, or say, 61.56 miles an hour. A reference to Mr. Rous Marten's article (published in *The Engineer*) will suffice to show that this has been most thoroughly beaten. We have, of course, yet to hear what United States railway men have to say concerning the race. Their comments can scarcely fail to be interesting."

The comment which is most "interesting" is not that of the newspapers, but of the trial made on the New York Central road on September 11, news of which will, of course, have reached our readers before this will. In this run the distance taken was 436¼ miles, which was made in 411¾ minutes, including stops, or at an average speed of 63.62 miles per hour. There has been some dispute about this also. The weight of the cars hauled on the New York Central road was nearly four times as heavy as that of those on the English trains. On the other hand, the grades on the English lines are considerably heavier. It is also said—which is true—that a helping engine was used in going up the heavy grade from Albany to West Albany, a distance of about 3 miles, and that the time of arrival at East Buffalo was taken without stopping. If the train had been slowed down before reaching East Buffalo, and brought to a dead stop, of course some time would have been consumed thereby. On the other hand, owing to the frequent grade crossings, on the New York Central line, there are many more places where speed must be slackened than there are on the English roads, where such impediments are much less common.

In view of the performance on the New York Central road, it may now be expected that the comments of *The Engineer* "can scarcely fail to be interesting."

* The italics are ours.

† This refers to a run made before that of September 11.

MATHEMATICAL PAPERS.

IN reviewing the last volume of the Transactions of the American Institute of Electrical Engineers, the London *Engineer* says: "A few years ago the United States would have been the last place in which to seek elaborate mathematical theorizing about and all around engineering problems. It is, indeed, doubtful if anybody does seek it; it seems to bubble out in some places, a pretty, sparkling stream at first, but no sooner coming in contact with things terrestrial than it generates mud—thick, or sometimes sloppy mental mud. But, as we have remarked, it does nobody any harm. No one need go to the meetings where abstruse mathematical papers are read, and no one need follow the rules which are given as the result of it all, if, indeed, the authors remember to give any rules."

It is, perhaps, not extraordinary that young students with the laurels of their graduation honors still fresh and green in their heads should write such papers; the grievance which those of us who are growing old and have had experience of more or less value is, that these young fellows insist on reading such papers. We don't quite agree with *The Engineer* that they do no one any harm. Of course if young fellows who know a great deal about mathematics, but have never studied the laws nor the limits of elasticity of an ordinary audience, choose to write and read such papers, no one has any good ground to interfere if due notice is given of their dire intention. The trouble is that they don't give such notice. We go to meetings with the placid expectation that some one who has done something that is creditable and well worth doing will read a paper and tell us of the difficulties he encountered, and how he overcame them, and what he accomplished, its value, and many other things that would be entertaining or profitable, and after a reasonable amount of time—say 20 minutes—has been thus occupied, that then there will be a discussion in which the old fellows and the young ones will all tell without boring their audience, what they know or have learned or want to know and learn of the subject in hand. Such proceedings are agreeable and refreshing, and we come away feeling strengthened for the struggle which must be renewed daily. Instead of this what actually often does happen is, that some paper is announced with a taking title for a given meeting, which leads to the belief that the kind of diversion and instruction indicated will be dispensed. On such occasions it happens at times that some youth starts in on his manuscript. First he stands on one leg of a formula and then on the other. Then he gyrates about an hypothesis which he assumes to be a fact, and weaves a spider's web of integrations and disintegrations on the blackboard; he balances possibilities in learned figures of speech, until none who hear him can tell whether he is trying to prove that the toes of his boots represent the square root of his understanding, or the end of his coat-tail is a function of his neck-tie. All we know is that what he is giving

us is totally unintelligible to the hearer, and we have a strong suspicion it is equally so to the reader. The authors of such papers are the chronic bores of technical associations. The reform which is proposed is that some committee should sit in judgment on the papers to be read. If they contain a little mathematics they should be designated by an X in their announcement, if more than a little by XY, and if much by XYZ, and then the said committee should provide cakes and ale in an adjoining room, to which members could retire while the author of the paper was practising his vocal exercises and his mathematical gymnastics.

TRADE CATALOGUES.

THE enormous increase in this department of literature—if it be literature—within the present half of this century is one of the noteworthy phenomena of our time. Not only has it increased in quantity, but it has also been improved in quality. Some of the choicest examples of typographic and what may be called mechanical art or illustration will be found in trade catalogues. The paper, press-work, engraving, and descriptive matter in some of these publications are often of the very best, and attention has, in these pages, repeatedly been called to the fact that the best treatises extant on many subjects are such catalogues. Still, considering the fact that those who prepare and issue them are often possessed of more information concerning the subjects to which they relate than any other persons, it is somewhat remarkable that their work as authors or compilers generally has so little value, excepting perhaps in the limited sphere for which it is intended—that is, for selling the appliances or commodities which are described; and even that purpose, it is thought, is not accomplished as fully as it might be if the authorial work was better done. It may be said, though, that its deficiency is not generally due to a lack of knowledge of those who write, but more to a lack partly of what Herbert Spencer calls "constructive imagination" and power of expression. That writer, in the admirable memorial notice of the life of the late Professor Tyndall, which was published in *McClure's Magazine* for March, 1894, says:

"There prevail, almost universally, very erroneous ideas concerning the nature of imagination. Superstitious peoples, whose folklore is full of tales of fairies and the like, are said to be imaginative; while nobody ascribes imagination to the inventor of a new machine. . . . As rightly conceived, imagination is the power of mental representation, and is measured by the vividness and truth of this representation. . . . This constructive imagination, here resulting in the creations of the poet and there in the discoveries of the man of science, is the highest of human faculties. . . . Good exposition implies much constructive imagination. A prerequisite *is the forming of true ideas of the mental states of those who are to be taught*;* and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess. Of constructive imagination, as displayed in this sphere, men at large appear to be almost devoid."

It is to the latter deficiency, chiefly, that the shortcomings of trade catalogues are due. An editor learns, perhaps sooner and oftener than other people, that that quality of mind which enables a person first to thoroughly comprehend a subject, and then enables him to assume the mental attitude with reference to it which a person ignorant of it occupies, is a rare one. Now the difficulty with most of the authors of trade catalogues is not that they have inadequate understanding of the subjects they write about, but that they can't conceive how it is regarded and appears to those who know little or nothing about it. They not only assume that their readers know more about the subjects which they are writing about than they really do, but the writers seem often to be oblivious of the fact of the total absence of knowledge in the minds of the persons they are writing for, or, as Mr. Spencer has expressed it, they are incapable of "forming true ideas of the mental states of those who are to be taught." It is nearly always safe to presume on the ignorance of readers, and it is seldom that writers explain things too clearly.

Another curious fact is that persons who are unaccustomed to writing for publication sometimes have an idea that if what they write is to be printed, it would not quite fulfil its purpose if it was expressed simply and clearly and was easily understood. To give it the appearance of profundity they will make it incomprehensible. If the same persons should take a stranger through their shops they would probably give oral explanations of the construction, operation, or mode of manufacture of what they are producing which would be in every way clear and readily understood, or if they have occasion to write an informal letter of explanation or instruction, they will express themselves in the most lucid way, but if they are required to write anything for publication—to use an ordinary expression—they are apt to "mix things up."

Then there is another obstacle in the way of trade catalogues assuming the form and character which would make them most useful—that is, that their purpose is to aid in the sale of what is described in them. The animus of the salesman is nearly always behind them. Now modesty and reticence are not virtues which are cultivated too much by those whose business it is to make the merits of what they have for sale known. It is also generally true that the less experience and skill he has in his calling, the more is he likely to boast of the superiority of his "line" of goods. This becomes a habit, and when such people have occasion to prepare a descriptive catalogue of what they have or make for sale, they are very apt to follow their usual habit and begin by boasting and laudation of what it is the aim of the publication to sell. The general fact is recognized that it is difficult for a person who does not sell goods to give valuable instruction to those who do, but it is respectfully submitted that to begin a catalogue by boasting and explaining the character, the construction, the principles, the operation, or the uses of the appliances or commodities which it is one of the purposes of such publications to describe, is an inversion of the natural and logical order in which people's minds are influenced. Thus, suppose a salesman has a new kind of monkey-wrench, let us say, for sale. If in an interview he dilates at great length and eloquence on the merits of the wrench, what can be done with it, brags of its superiority over those which his competitor is selling, tells of how many orders he has received and how many he expects to get, and asserts that his wrench will work where no other wrench could screw or unscrew anything—all that is apt to fall on barren ground, unless the victim understands the construction of the wrench first. Explain to him how by some ingenious mechanical device all these advantages are attained, and he will be interested, and boasting may then do some good. The same principle applies to catalogues. If a person finds on the first page, in displayed type, the most fulsome commendation of the character, quality, and merits of the articles described, he is apt to feel that it is all rubbish and thrust it into the waste-basket. If, however, a tool or machine or some material which he uses is illustrated and clearly explained, so that it is easily understood, then commendation may find a place in his mind. For the composition of catalogues, and in selling anything, the general principle may therefore be laid down—explain first and boast afterward.

It may also be assumed that those for whom trade catalogues are intended are *not* thoroughly acquainted with "the state of the art" to which they refer. A brief and clear exposition of it brought fully up to date will generally be of interest to all who are concerned in the use of the articles described. A statement will then naturally follow of the improvement which it is the purpose of the catalogue to set forth. Trade catalogues, it seems certain, would accomplish their purpose more effectually and be of more general service

* Italics are ours.

to those for whom they are intended if they assumed the character of elementary treatises, which some of them now do. If they did, there would be an almost boundless field of usefulness for them outside of their purpose of selling the articles described and lauded in their pages. If they were written by persons—as they generally are—who have devoted their lives to the subjects to which they refer, and if the aid of competent draftsmen was called in, such catalogues might become the most complete records of engineering progress in existence, and be the sources to which all would go for information. Their great defect now is generally the want of clear and full explanation and elucidation of the subjects to which they relate, although there are some notable exceptions to this. As technical education becomes more general, we may hope, and, in fact, can now see, that great improvement has been and is being made in this kind of literature. Much of it though has served to show how inadequate the instruction which is given in most technical schools is to enable their graduates to write clearly—a deficiency which it is to be hoped will be provided for. Capacity for lucid and adequate expression, either in writing or speech, is one of the most valuable qualifications a person can have for the battle of life, in which we must all take a part.

NATIONAL MANUFACTURERS' ASSOCIATION.

On another page the address or call for a convention of manufacturers, which is to be held in Chicago in October from the 15th to the 17th, is republished. This has been issued by Mr. Thomas P. Egan, of Cincinnati, the Vice-President of the Association, who is its author and also President of the J. A. Fay and Egan companies, the celebrated manufacturers of woodworking machinery. It will be seen, it contains the declaration that an organization bringing the manufacturers together to work for the common good of all, without party interests, but simply with the good of the country and its industrial welfare at heart, can be of incalculable value. To this patriotic sentiment we, and doubtless our readers generally, will respond with a hearty Amen.

It is said, further, in the manifesto which has been issued, that "the manufacturers propose never to allow themselves to be disregarded and their interests to be seriously affected by any action of Congress prejudicial to the good of the country without being heard from." That is right. If Congress takes any action prejudicial to the good of the country, the manufacturers should be the first to talk out. Such action, it is said, the last Congress did take when it "rescinded the valuable reciprocity treaties which were then in force, and framed a tariff under which it is almost impossible for the manufacturers to exist."

Now, if the latter statement is true, and if the remedial effects of reciprocity are what they are here intimated to be, the subject ought to be very fully discussed at the proposed meeting. At present there does not seem to be any general agreement among manufacturers about it. The commonly held opinion probably is that a little reciprocity is good, much is doubtful, and universal reciprocity would be deadly.

In some of the engineering and railroad associations which hold annual meetings the excellent practice exists of setting apart an hour of every session for the discussion of questions propounded by members. The manufacturers' convention might follow this practice with advantage to the interests of its members and the general edification of the public. The following questions might be suggested for discussion:

Would reciprocity be an advantage to manufacturers?

How much of it would be good for them?

If universal reciprocity is bad, how should it be limited?

But is it true that it is almost impossible for the manufacturers to exist under the present condition of things? Is it not, on the other hand, the fact that from every direction for months past there have come reports of improved business, higher prices—rails, for example—for products and wages, more employment of working people, and increased prosperity generally? One of the things which might be done advantageously in Chicago would be to make a sort of diagnosis of the condition of the manufacturers in the country, and ascertain whether they are on the verge of dissolution. We don't believe they are; and probably the companies of which Mr. Egan is the President are selling more or less on credit, as they have always done, with the expectation of being paid, and with comparatively little fear that their customers generally are on the verge of ruin.

Some strong confirmatory evidence, indicating that existence is not impossible for manufacturers in this country, comes from the other side of the Atlantic. In a recent number of *The Engineer* a letter from its Sheffield correspondent was published, in which it was said that:

"Some of our most experienced and observant manufacturers and merchants who have made frequent visits of late years, and particularly during the last 12 months, to the United States, anticipate much keener competition from that quarter than we have yet known. Steel billets have been ordered for delivery in Sheffield—not in any great weight, it is true, but to an extent quite large enough to show what might be done. Then, in regard to files, a larger user, whose works are in Sheffield, tells me that he has no other tools on his premises. He mentioned the brand which he finds so well suited to his purpose, adding that it was always true alike, and very much cheaper than anything he can get made on this side. These files are machine-made, the machines varying in size from that of a small striking apparatus to the more ponderous appliance required for the largest kind of files produced for the heavy trades. Female labor is employed. In one room he saw between 60 and 70 'lady operators' working at these machines, and turning them out in enormous quantities at prices with which no English market can compete. Here we are still fighting the battle of machine *versus* hand-cut, and, according to my information, the machinery we have in use has been discarded by the Americans years ago. The patentees declined to let English manufacturers use their inventions even under a royalty, intending to establish agencies for their files in Sheffield and other towns.

"Mr. Robert Belfitt, chairman and managing director of Messrs. George Butler & Co., Trinity Works, Sheffield—a firm with a district reputation for the production of fine art cutlery—has returned from a visit to the United States and Canada. It is the first visit Mr. Belfitt, who was Master Cutler a few years ago, has paid to these markets. He found what is not so generally known as it ought to be, that the Americans are manufacturing a great deal of their own cutlery, although for high-class goods they continue to call upon Sheffield. The reason for their not going in for the superior grade is, there is good reason to believe, not so much through inability to make them, but simply because, with their wonderful inventiveness and labor-saving appliances, they find it more profitable to concentrate their attention on lines of which great numbers are required. In fine pocket cutlery the orders are comparatively light; but in the articles of every-day use the capabilities of the various United States markets are immense, and that is the trade the American manufacturer aims at getting. In this enterprise he finds the German the keenest rival; but, with the advantages of duty and more effective appliances for production, as well as greater subdivision of labor, the German is being gradually displaced. The United States 'make' of secondary cutlery in general use there is daily increasing, and is being put upon the home markets of the Northern, Southern, and Western States at rates which secure the business for the American firms. Mr. Belfitt appears to have been particularly struck with the ingenuity of the Americans in the smaller lines of hardware, such as locks, door-knobs, and knickknacks useful in house-building and in the house itself. In these things he candidly admits the Americans beat us completely. Mr. Belfitt looks forward to a fairly good trade with the United States as well as with Canada."

This shows not only that we are holding our own, but that our manufacturers are able to assume an aggressive attitude and are able to compete with England in their own territory.

Since the first part of these comments were written the following items of news were received:

"As an evidence of the increasing prosperity among railroads and those engaged in the manufacture of railroad rolling stock, J. A. Fay & Co., the world-renowned and justly celebrated manufacturers of car and railway wood-working machinery, have to report an increasing business in this line. They are now furnishing machinery for the Mexican International Railroad Company, the Illinois Central Railroad, for their new shops at Burnside, Ill., the Queen & Crescent and the Big Four Railroads, Missouri Pacific Railway Company, Jacksonville, St. Augustine & Indian River Railway, and have recently equipped the new shops for the B. & O. S. W., at Washington, Ind., Pittsburgh & Lake Erie Railroad Company, Kansas City & Gulf Railroad, Mobile & Birmingham Railroad Company, Lenoir Car Company, at Lenoir City, Tenn., New York Central, for their Utica shops, and a number of others. They anticipate an increased trade in this direction for some time to come."

Certainly this indicates prosperity, which has come, apparently, in spite of what, in the call referred to, seems to be regarded as adverse legislation.

It would be extremely interesting if the views and the general sense of manufacturers could be ascertained, not only with reference to their present condition and the general business prospect, but also on some general abstract principles. The discussions in Congress, and by politicians generally, are shaped so much for the mere purpose of gaining party advantage that it is difficult to know what their views or those of their constituents really are.

If, for example, it could be shown clearly why an exchange of products with some people is good for us, while trading with others is very bad, it would throw light into places in which some persons now have difficulty in seeing clearly.

There are some other general propositions which might be discussed, perhaps to the edification, but certainly to the entertainment of the hearers, besides that one of when, where, and how an exchange of products is an advantage. The following are suggested:

Is the general prosperity of the community promoted by having commodities cheapened or endeared?

Should it be the aim of government, capitalists, and society generally to facilitate the beginning and the growth of new enterprises and aid in promoting their business and prosperity, or is the concentration of manufacturing and other business under the control of great corporations and firms a benefit to the country?

What are the principal obstacles which are encountered in the transaction of honorable business with such corporations and firms?

Could a practicable code of business ethics—similar to those in force among professional men—be formulated for manufacturers, and would it be possible, under an organization similar to the one contemplated by Mr. Egan, to hold them amenable to it?

Probably one of the most serious difficulties which manufacturers must contend with now is labor troubles and strikes. That this difficulty is not peculiar to our country, there is abundant evidence to show. At the recent meeting of the Iron and Steel Institute at Birmingham, England, a paper was read by Mr. Daniel Jones, Secretary of the South Staffordshire Iron Masters' Association, on "The Iron Industry of South Staffordshire," in which he said:

"No account of a great industry would in these days be complete without a reference to the methods adopted for regulating the wages questions. It is obvious that a district like South Staffordshire, which is placed under great disadvantages in respect to carriage, water in the mines and old works, cannot afford to run any risks of diverting trade by foolishly entering upon strikes and lockouts. This has been wisely taken into consideration by the leaders of the ironworkers and coal miners, who are as well acquainted with the conditions of the trade as they were. Great credit is due to them that they should have so carefully studied the subject, and have formed such sensible conclusions as to what was best for their interests. As a result, we have wages boards both in the iron and coal trades, which have so far worked satisfactorily. This would be realized when he said that for 23 years they had been without a strike, in a district which was proverbial for them, and of a serious character. He must not forget to say that the principles upon which these wages boards have been founded were borrowed from the North of England Conciliation and Arbitration Board. From a long experience as the employer's secretary of the Midland Iron and Steel Wages Board, he strongly recommended to all the great trades of this country that they should adopt our methods. The principle is no longer to be considered experimental, but is established by a 23 years' experience with unfailing success; and the future of the South Staffordshire iron and steel trades is not so much a question, in his opinion, of supplies of coal and iron or of trade, as it is of the wisdom to be shown by both employers and employed with regard to labor questions."

No facts nor figures need be quoted to show that both here and in England the losses to employers and employed, resulting from strikes, is enormous. Regarded in the aggregate of a number of years, it has been in this country and in Europe a heavy expense which has been added to those which must necessarily be incurred in the transaction of business. Therefore manufacturers who can avoid strikes have a great advantage in competing for business over those who are subjected periodically to this kind of interference, with all its attending loss. Therefore, what Mr. Jones has said of the importance of wisdom in dealing with the labor question applies not only to the industries of South Staffordshire, but to those of the whole world. If the iron manufacturers of England deal with this subject more wisely than those do who expect to assemble in Chicago, the former will be in a better position to compete for the business of the world than the latter. It therefore seems to be of the utmost importance that the manufacturers should form the wisest possible opinions on this subject, to be succeeded when the occasion arises by correspondingly wise action. Unfortunately for us our great civil war left a heritage in the very commonly held opinion, that all social and political evils may be settled by fighting. The great issues which brought about that unhappy contest between the two sections of the country were decided by bloodshed, and many people hastily reason that if such great questions were thus decided, lesser ones may be submitted to the same kind of determination; and now whenever there is a strike or a rumor of a strike, the first thing that some people demand is to call out the military. The manufacturers and their employés in England, by long and bitter experience, have learned wisdom, and as indicated by the observations which have been quoted, they now aim to settle such disputes, not by violence, but by the peaceable ministrations of boards of conciliation and arbitration. The practical effect of this is to reduce the cost of production, by avoiding the wasteful expense of strikes. There is no subject which is more worthy of consideration by the manufacturers at their Chicago meeting than this. If some new method of manufacturing had been discovered and was used in Europe which materially reduced the cost of production, hardly any expense would be spared by our manufacturers here to learn all about it. Now, as a matter of fact, the methods which have been adopted in Europe for settling labor disputes have materially lessened the number of strikes there, and thus reduced cost. Would it not be worth while to study the methods to bring about such results by appointing some kind of commission, and have them make a tour of investigation and report on what has been done and on the methods employed, in other countries, to avoid labor troubles and establish industrial peace instead of war? It looks as though more reciprocity, more general knowledge of the underlying principles of exchange, more fair pl y in trade, more conciliation and arbitration, and compromise—if need be—would do more for the general prosperity of manufactures than anything else which the association that will meet in Chicago can promote.

NEW PUBLICATIONS.

THE UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1895. London: The Directory Publishing Company, Limited, 8 Catherine Street, Strand, W. C. 342 pp., 5½ × 8¼ in., 10 shillings.

This attempt to make a universal directory of railway officials, it is said in the preface, is believed to be the first one which has ever been made. It is certainly very much needed, and will be of great use to all who have business or other relations with railroad companies and their officers. It is said to contain upward of 8,500 directors and chief officials, including the chief clerks and chief draftsmen.

The table of contents shows that the countries included are England and Wales, Scotland, Ireland, Europe, Asia, Africa, Australasia, North America, Mexico, Central America and West Indies and South America.

Of course, with the great mass of material which had to be handled, but little typographical display was possible. The names and addresses which are given are, therefore, printed in small type, but which is quite legible with good eyes or good glasses or both, excepting in some cases where the printing is bad, which is the case on some of the pages, although generally the work is fairly well done. The book fills a long-felt want, and its success is probably assured.

ADDRESS OF R. T. CRANE TO HIS WORKMEN, JULY 4, 1895. 15 pp., 5½ × 7¾ in.

Last Fourth of July Mr. R. T. Crane, President of the Crane Company, and also of the Crane Elevator Company, of Chicago, told his employés that just 40 years before, on the Fourth of July, 1855, a furnace which he had built for a brass foundry was ready, and being anxious to see that it worked all right, he took off his first heat on that day. The anniversary of that event he made the occasion of an address to his workmen, in which he advocated peace and good-will between employer and employed. In this address he calls attention to the untold anxiety and worry which a person must endure in building up a successful business. If the difficulties of carrying on a great business could be instilled into the minds of workingmen, so that they would realize them fully, it would be a great gain; but with the very limited range of experience and the moral and mental qualifications of many employés such an appreciation is difficult or impossible.

The solution of the labor question or the adjustment of the relation of the employer and his employés must be by evolution, and that is a slow process. Mr. Crane's address has probably helped this along, as all honest efforts do.

In reading addresses of this kind, though, it often seems as if more would be gained if the speakers, instead of preaching in favor of peace and good-will, would advocate fair play on both sides. The difficulty generally is that there is not sufficient disposition or capacity on one or either side to deal justly or *righteously* with the other. Amicable agreement is, then, difficult or impossible.

Mr. Crane ends with the prediction that if the famous mechanics, artisans, and laboring men should adopt and enforce legislation that will deny their rights to one class of a community while guaranteeing them to another class, just so certainly will this republic of ours become a memory, and despotism will follow; which is doubtless true, but the hypothesis is a two-legged one, and Mr. Crane's boot would fit either.

AN ELEMENTARY TEXT-BOOK ON STEAM ENGINES AND BOILERS. For the Use of Students in Schools and Colleges. By I. H. Kinealy, Professor of Mechanical Engineering, Washington University, St. Louis, Mo. New York: Spon & Chamberlain. 236 pp., 6 × 8¼ in., $2.00.

There is a class of books which always recalls Lincoln's immortal story of the Kentucky Baptists, who were too bad to be saved and too good to be damned. The one before us belongs to this class. The author tells us it "was written solely as an elementary text-book for the use of beginners and students in engineering, but more especially for the students in the various universities and colleges in this country." Now, if it was intended for an elementary book for beginners, why was it sprinkled with mathematics, which, to say the least, is not easy reading for a beginner? If, on the other hand, it was intended for "students in universities and colleges," it would seem, from some of the observations it contains, as though a certain amount of imbecility of mind was assumed in that class. Why, for example, should such students be told that "some slide-valve engines are heavy, well made, and made of good material; others are slight in weight, poorly made and made of the poorest material," and that "the cylinders of engines are made of cast iron, with walls sufficiently thick to stand the stress induced by the pressure of the steam," etc. Can it be imagined that any students ever present themselves at Washington or any other university who require instruction like the following?

"The boiler is simply a closed vessel which contains the water of which the steam used in the engine is formed. The boiler may be of any shape or size.

"The chimney is the part which carries off the products of combustion.

"The fuel is put in the furnace on the grate, and is there burned. During the combustion of the fuel heat is generated," etc.

This sort of writing for "students" is simply twaddle. Then the explanations often do not explain. Supposing a student who does not know what an eccentric is should be told, as he is in this book, that "the eccentric is simply a cast-iron disk through which the shaft passes, and which moves the valve of the engine," what sort of an idea would he form of that important part of a steam engine's mechanism?

The book seems to have been constructed on the pigeon-hole system—that is, when the writer found anything relating to the general subject he made a note of it and put it into a pigeon-hole or other receptacle. When this was filled he classified the material, divided it into chapters, and had it printed, and now labels it as intended for students.

The engravings are mostly reproductions—and bad ones at that—of engravings from advertising catalogues; one of them, on page 60, is printed upside down.

The subjects treated of in the different chapters are: Elementary Thermodynamics; Theory of the Steam Engine; Types and Details of Engines; Admission of Steam by Valves; Valve Diagrams; Indicator and Indicator Cards; Compound Engines and Condensers; Heat and Combustion of Fuel; Boilers and Chimneys, all of which are better elucidated in other books. An appendix is devoted to the Care of Boilers. It is to be regretted that the excellent "Instructions to Boiler Attendants," issued by the Manchester Steam Users' Association (which we have reprinted in the form of a "reference card"), did not find its way into the pigeon-hole referred to, and was not added to the appendix, as it would have increased the value of this part of the book, it may be said roughly, about 500 per cent. The climax of inferiority is reached by the omission of an index.

REPORT OF THE PROCEEDINGS OF THE TWENTY-NINTH ANNUAL CONVENTION OF THE MASTER CAR-BUILDERS' ASSOCIATION, held at Alexandria Bay, New York, June 11, 12, 13 and 14, 1895. John W. Cloud, Secretary, 974 Rookery, Chicago, Ill. 437 pp., 6 × 8¼ in. [Not quite standard.]

This report comes to us this year bound in stiff paper covers, which is a great improvement. A review of the contents would take more time and space than can now be given to it, but we can afford the observation that the amount of care and labor which must be given to the preparation of the great quantity of copy which is condensed in the pages before us only those who have done the work can realize. The master car-builder or railroad superintendent who receives his bound volume all complete and arranged in convenient form for use and reference should fold his hands and close his eyes for a moment, or, better still, write a note and express his thanks to the Secretary for the work which he has done. The typography, engraving and general arrangement are all excellent, and it would be possible to meander into comments indefinite on the contents, but for this there is not time either for the writing or probably for the reading.

It is generally more profitable to observe our faults than to contemplate our merits. Perhaps the same is true of books—at any rate, from the reviewer's standpoint. Although the more permanent binding is appreciated, the lettering on the back might be improved. The title is simply "M. C. B. Ass'n, Vol. 29, 1895." Now, while all the members of the Association and others perhaps know what these cabalistic letters mean, to the great majority of mankind they will be as Greek or Sanskrit. These reports will go into libraries, public and private, and will be kept there for reference. Is it at all likely that a reader in, say, the Astor Library, or that of the Institution of Civil Engineers, or British Museum in London would know what M. C. B. means? For the convenience of members, too, the place where the meeting was held should be inscribed on the back. Most of us can identify a given meeting five or ten years after it was held much better by some association with the place than by the ordinal number of the meeting.

There would seem to be room for improvement, too, in the quality of the paper. A principal component of that in the book is wood pulp, which in 10, 20, or 50 years will decay or be so brittle that it cannot be handled without destruction. These reports are not of a merely ephemeral character, but should be permanent records of what the association has done. The de-

velopment of railroads is one of the great facts of history and the advancement of civilization, and in the future what the Master Car-Builders' Association has done will be a matter of interest to those who will come after and succeed us. It would therefore seem to be worth while to preserve its records in some form which will not speedily go to de-truction.

Lastly, the index is inadequate for a book of reference of this kind. It ought to be possible from it to find any important subject referred to in the volume. Take as an example screw threads. How many people are there outside of the Association to whom it would probably occur to refer to the word "standards" in order to find what the Association has done about screw threads. Or suppose it is desired to find what some member said on a certain subject. Not one of the members' names are indexed in connection with the discussions. It is doubtful whether people who make good indexes will get their reward in this world—in fact, it is quite certain they will not—but if things are "evened up" hereafter they will probably be honored then and there, wherever that may be, and have some kind of new and improved spiritualized electric-lighted halo of greater brilliancy than the other chaps who have not made good indexes.

THE MICHIGAN ENGINEERS' ANNUAL, *Containing the Proceedings of the Michigan Engineering Society for* 1895. Published by the Society, F. Hodgman, Secretary, Climax, Mich. 224 pp., 5¼ × 8¼ in. [Not standard size.]

The time seems not far off when every State in the country will have its own local engineering society. The volume before us is an indication of this. We have here a well-printed book containing the following papers: Waste and Consumption of Water, by G. S. Williams; New Lock at Sault Ste. Marie, by J. L. Callard; Title by Possession, by Judge F. A. Hooker; Difference in Direction of Magnetic Needles, by C. L. Berger, L. Bechman, W. and L. E. Gurley, and F. Hodgman; Cement and Concrete, by V. Sebring Hillyer; Difficulties in Manufacturing, by C. E. Bement; Old Surveys in Detroit, by Thomas Campan; Highway Bridges, by H. K. Vedder; Special Assessments, by M. C. Taft; Grand Rapids Plaster Quarries, by C. H. Redman; Sewer Building at Port Huron, by F. F. Rogers; Mineral Resources of North Arkansas, by E. L. Hayes; The Austin Masonry Dam, by E. W. Groves; Highway Grades, by John Randall; Logging Railroads, by H. C. Thompson; Work of the Propeller Wheel, by H. C. Pearsons; A Hard Tramp, by F. Hodgman; A Queer Man, by F. Hodgman; and What I would Be, by F. Hodgman.

The volume, as has been said, is well printed in good large clear type. The binding, however, is of that execrable kind which holds the leaves together as though they were riveted—as they are by wire—and they require to be pried apart in order to read comfortably on the inner margin. On the outside there is a margin over an inch wide, while on the inside the accessible margin is only about ¼ in. This is a very common defect of books, issued even by the most prominent publishers. If one half of the outside margin had been put on the inside, the pages could be read with comfort. As it is, the wire binding, and the narrow inside space are irritating to the reader.

Another defect of the book is that there is no index—only a table of contents, which suggests a story; the writer in his early days, like many other boys, good and bad, went to Sunday-school. There are conflicting traditions bearing upon the question whether he was numbered among the former or the latter—probably there was in him the usual mixture of cussedness and imbecility characteristic of boys in the active period of life, and he doubtless assisted his companions in making the lot and duties of the superintendent of the school unhappy. The functionary who acted in that capacity was an elderly, fat, pious and solemn individual named Martin Lohr. The sessions of the Sunday-school were held in a basement lecture room, which occupied one-half of the space below the general meeting room of the congregation, which was above. In the other half of the basement the hot-air furnaces for heating the church were located, and, as a consequence, it was nearly always filled with a suggestive sulphurous odor, which escaped from the anthracite coal that was used as fuel. The biers which were then used on funeral occasions, the tools for grave-digging, and other uncanny appliances were stored in this place. One Sunday, after the boys had been more than usually insubordinate, the venerable superintendent lectured them for some time, which had no effect; he then scolded, at which they were not awed; until finally in desperation he said: "If you boys do not behave better I will fit up a little hell in the adjoining furnace room and have some of you shut up in it." The threat was so dreadful that memory fails to recall whether the conduct of the boys was improved thereby; but in looking over books, which of necessity must be used as references chiefly, and which are indexless, we are led to hope that some literary Martin Lohr might arise and establish a place of punishment for authors and publishers who are guilty of such delinquency.

BOOKS RECEIVED.

EXAMINATION OF WATER FOR SANITARY AND TECHNIC PURPOSES. By Henry Leffman, M.D. Third Edition. Revised and Enlarged with Illustrations. Philadelphia: P. Blakiston, Son & Co. 154 pp. 4½ × 7¼ in., $1.25.

TRADE CATALOGUES.

[IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3½ in. × 6½ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	8¼ in. × 10¾ in.

WOOD WHEELS GRINDING AND POLISHING MACHINERY. Builders' Iron Foundry. In two leaflets this company announce that they have installed machinery for the manufacture of wooden wheels covered with heavy oak tanned leather for polishing metal and other work. A cluster of these wheels is represented in one of their publications.

RED LEAD AND HOW TO USE IT. By Ralph K. Wing. National Lead Company, No. 1 Broadway, New York. 24 pp., 4¼ × 7¼ in. [Not standard size.]

In this well-printed pamphlet Mr. Wing, the travelling representative of the National Lead Company, has compiled the opinions of various experts on the uses and advantages of red lead for painting iron or steel, and also sets forth some of the disadvantages of other kinds of paint. Some account of actual tests made by various paints and samples, showing the color of pure red lead and combinations with various proportions of lamp-black, are given. Short chapters on the Economy of Red Lead; Mixing; Preparing Iron for Painting, and Purity and Quality of Paint complete the book.

CATALOGUE OF COLD SAW CUTTING-OFF MACHINES. Newton Machine Tool Works, Philadelphia. 32 pp., 6 × 9 in. [Standard size.]

Probably very few machinists or mechanical engineers will look through this book without being surprised at the variety of cold sawing machines and the uses to which they are adapted. In the catalogue before us no less than twenty-six different cold sawing machines are illustrated and described, besides a band sawing machine, also intended for metal.

An idea of the work which can be done on these machines will be obtained from the following extracts from the descriptions:

No. 0 machine will cut round bars up to 2									in.; square up to 2					in.
No. 1	"	"	"	"	"	"	"	3¼	"	"	"	"	3	"
" 2	"	"	"	"	"	"	"	5	"	"	"	"	4½	"
" 3	"	"	"	"	"	"	"	7	"	"	"	"	6	"
" 4	"	"	"	"	"	"	"	9	"	"	"	"	8	"
" 5	"	"	"	"	"	"	"	12	"	"	"	"	11	"
" 1 I-beam machine will cut off beams up to													15	in.
" 2	"	"	"	"	"	"	"	"	"				20	"
" 3	"	"	"	"	"	"	"	"	"				24	"
" 4	"	"	"	"	"	"	"	"	"				12 × 38	"
" 5	"	"	"	"	"	"	"	"	"				15 × 56	"
" 6	"	"	"	"	"	"	"	"	"				18 × 60	"

Other machines for special uses are made and illustrated, some of which can be used as cutting-off machines and as rotary planers. What is called a stock-yard machine, which is intended to take the place of high-speed or friction cold saws in steel and iron works, is also illustrated and described. Besides these the company makes a machine designed for trimming the edges of armor plates after they come from the rolls. Still others which are illustrated are for cutting off the heads and sprues of large steel castings, and for cutting off car and loco-

motive axles. The last illustrations are of saw sharpening machines. A good index completes the pamphlet. The illustrations are fair wood engravings, which show the machines very well, but are not of superlative excellence.

TOBIN BRONZE. The Ansonia Brass and Copper Company, 19 and 21 Cliff Street, New York. 36 pp., 3¾ × 5¾ in. [Not standard size.]

On the first page of this pocket pamphlet the publishers say that they furnish Tobin bronze in the following forms: Pump Piston-rods and Yacht Shafting, Rudders, Centre Boards, Pump Linings, Condenser Heads, Fin Keels, Tube Sheets, etc., Round, Square and Hexagon Bars. In several pages which follow the qualities and characteristics of the metal is described; tables of weight, reports of tests, and a cloud of testimonials are given, from which the reader can learn more than he ever knew before about the merits of this metal; and if he happens to be an engineer, he will doubtless learn something which will be to his advantage.

BAKER HOT WATER NON-FREEZING CAR HEATERS. William C. Baker (Inventor), 143 Liberty Street, New York. 96 pp., 6 × 9 in. [Standard size.]

The animus of this publication is so well set forth in its preface that we cannot forego the opportunity of quoting from it. It is said:

"In the year 1866 Mr. W. C. Baker invented and introduced the now universally used Baker car heater. This heater was the first innovation on car stoves. Since 1866 there had been no improvement on the Baker heater until 10 years ago, when he commenced making and putting into use the important improvements described in this book. His efforts have culminated in the production of a jointless, flexible, and absolutely fireproof heater, which cannot be broken in a wreck."

The catalogue before us is intended to describe and set forth the merits and characteristic features of this heater.

The original Baker heater is too well known to require description. As all railroad men know, it consisted of a stove with a coil of pipe inside, which surrounded the fire, and through which water was circulated and warmed, and then conducted through pipes below the seats, thus heating the car. This feature is still retained, and, as Mr. Baker says, "the fire chamber is surrounded by the generator coil filled with water. An air space outside of this coil is for the hot gases of combustion. Next is a sheet-iron casing, then sheets of non-combustible asbestos, and outside of all"—and herein is the important safety feature—"is the flexible, jointless steel casing one-fourth of an inch thick." This is made of soft steel, and will bear any amount of bending, doubling, or twisting without breaking. The steel casing is seamless and of cylindrical form, the top and bottom of which are also made of the same material. The smoke escapes through apertures in the top—which is also made of soft steel—⅜ in. in diameter, and these are the only openings through which fire could escape in case of an accident. This form of heater Mr. Baker claims gives complete security against fire in case of accident, and has the advantage of greater efficiency for heating cars in storms when trains are delayed than heating with steam from the engine has, gives a pleasanter heat, and is capable of better regulation.

Various forms of this heater are described and illustrated, and full detailed views of the various parts are given for convenience in ordering duplicates.

A new style of generator, the form of which may be understood if the reader will imagine two hollow rings of brass placed one above the other, with a space of about 12 in. or 15 in. between them. Now imagine these rings connected by vertical conical pipes—that is, pipes of this form—the wide ends of which are connected to the upper ring and the small ends to the lower one. These are filled with water which circulates through them. The rings are divided diametrically into two halves, and the half of the upper one and the half of the lower one, with the pipes connecting them, are all cast in one piece, and are therefore without joints excepting those by which the water pipes are connected to them. Mr. Baker is anticipating much success from this form of heater.

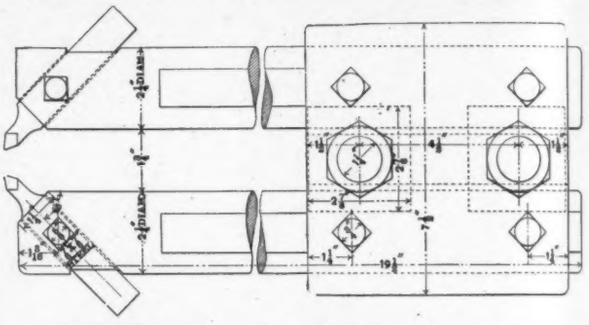
The illustrations in the book are excellent wood cuts, and the descriptive matter has that piquancy which is characteristic of the author's writing, speech and inventions.

The only criticism which we feel is needed is of the nature of a suggestion, and is, that if a sectional view corresponding to the exterior view on page 1 had been given, showing the internal parts of the heater, it would have aided those who are ignorant of its construction to understand how it is made, and with a suitable explanation would have enabled them to understand better how it works. It is nearly always safe to presume upon the ignorance of your readers.

NOTES AND NEWS.

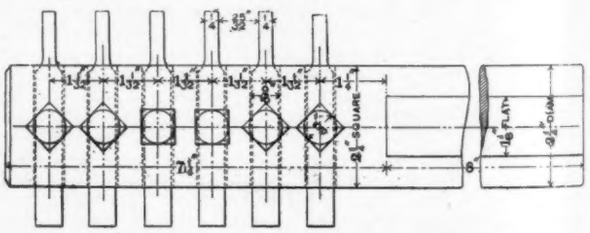
The Ram "Katahdin's" Trial Trip.—It is announced that the trial trip of this vessel, which was built by the Bath Iron Works, in Bath, Me., will take place on October 3. She will be run for two consecutive hours, and to fulfil her contract requirements must maintain an average speed for that time of 17 knots per hour.

Tools for Turning and Cutting off Piston Packing Rings.—There is in use in the shops of the Baltimore & Ohio Railroad a very convenient device for turning and cutting off piston packing rings, engravings of which are given herewith. After having bolted the casting, from which the piston packing rings are to be cut, to the face plate of the lathe, the first operation is to turn off and bore out the casting at one



TURNING TOOL FOR PISTON PACKING RINGS.

and the same time with the double tools, as shown in the sketch, taking rough and finishing cuts, the tools being set for finishing cut, the proper distance apart to give the required thickness of packing ring. Then the bar with the cutting-off tools is placed in the tool-holder, the cutting-off tools are so spaced as to leave a slight amount to be faced off the rings as the final operation.



CUTTING-OFF TOOL FOR PISTON PACKING RINGS.

All the cutting-off tools are brought into operation at the same time, but are not forced entirely through, sufficient metal being left to hold the several rings together. The tool in the end of the bar is then placed in the first groove and used as a facing-off tool, reducing the ring to the proper width and finally cutting it off; this same operation is gone through with each ring.

How the 4 ft. 8½ in. Gauge for Railroads was Fixed.—A number of versions of the origin of what is now the standard distance between the rails of modern railroads are current. The following from an English paper is the latest:

"It is said that when the bill for the London & Northwestern Railway was before the Parliamentary Committee the chairman pointed out that nothing had been said about the width of the gauge.

"The committee were just adjourning for lunch, and counsel for the company promised that the required particulars should be supplied when the committee reassembled.

"A hasty consultation took place, and they went out into the street at Westminster and measured the wheels of one of the old road wagons which used to ply between London and the provinces. It was found to be 4 ft. 8½ in. wide, and that measurement was inserted in the Railway Bill."

A more reasonable and probable one was given by correspondents in the *English Mechanic* some years ago. It was

that the gauge of the Liverpool & Manchester road was originally 5 ft. measured to the outside of the rails, which were 2 in. wide, making the inside gauge 4 ft. 8 in. It was found that in going round curves the cars and locomotives had not sufficient room between the flanges and the rails, and the distance between the latter was therefore widened ½ in., making the gauge what it is now, 4 ft. 8½ in.

The Slipping of Wheels.—A correspondent from Baltimore writes to inquire whether "when an engine is rounding a curve, do the driving-wheels on either side slip or slide? If so, which ones slip, and in what direction; or whether the cone shape of the tire and the fillet of the flange increases and diminishes the size of the wheels so as to allow them to pass in and out of curves without either of them having to slide? Also advise what bearing the elevation of the outside rail of a curve has on the subject."

If our correspondent will watch an engine or a car truck when it is moving slowly on a sharp curve, he will find that the flange of the front wheel next the outer rail will impinge against it, and that this forces the front pair of wheels laterally across the track and toward the centre of the curve. In other words, these wheels slip endwise. This movement of the front pair of wheels produces a twisting action on the rear pair of wheels on, say, a four-wheeled truck, which causes them to turn slightly about a vertical line drawn through the centre of their axle midway between the two wheels. The hind wheels, therefore, slip slightly, the one on the outer rail moving forward and that on the inner rail backward. With a six-wheeled truck or engine with six drivers, the middle pair of wheels would also slide sideways, but only half as far as the front ones do in a given time or distance, and there will also be some twisting action exerted on them, but not so much as on the back pair of wheels.

The coning of the wheels has an almost inappreciable effect on car or engine wheels in rolling around a curve. If the axles could assume a position radial to the curves, the cone of the wheels would help them around; but if the axles remain parallel to each other, the cone has an almost inappreciable effect, as was fully shown in a paper read by the writer at a meeting of the Master Car-Builders' Association in 1884, and which will be found on page 39 of the report for that year.—EDITOR.

Electric and Steam Railroad Competition.—Some idea may be obtained of the nature of the competition between the steam and electric railroads in the vicinity of New York from the following table, in which the distance, fare, time consumed in the journeys, and interval between trains are given. The fares, it will be seen, are about 25 per cent. less, but the time consumed in the journeys is nearly doubled. But, on the other hand, the intervals between trains on the electric roads are only one-sixth to one-twelfth as long. Obviously such competition is a serious matter to the steam roads.

From New York to	Distance.	Fare, Round Trip.		Time.		Interval between Trains.	
		Electric.	Steam.	Electric.	Steam.	Electric.	Steam.
	Miles.	Cts.	Cts.	Min.	Min.	Min.	Min.
Greenville	4.2	15	20	40	18	5	30
Bayonne	7.7	15	25	60	27	5	30
Newark	9	20	25	50	30	5	30
Orange	12	30	50	80	45	5*	30†
Elizabeth	13.5	35	50	80	40	5*	60
Bloomfield	13	30	45	80	50	5*	60

* Change at Newark. † Every 30 minutes morning and every 60 minutes rest of day.

A Mountain Electric Railway.—A correspondent of the London *Times* gives some further details respecting the new electric railway from Laxey to the summit of Snaefell, Isle of Man. The length of the new line is about 4¼ miles with a remarkably even gradient throughout. To insure steadiness and safety the company have adopted the Fell system of centre rail. The bearing rails, laid to a gauge of 3 ft. 6 in., are of Cammell's best quality of steel, 50 lbs. to the yard. Between these a double-headed rail (65 lbs. to the yard) is laid on its side, upon chairs, and is thus somewhat higher than the bearing rails. Upon the bogies of the cars are two sets of double wheels which clasp the centre rail and run along it; and also two gripper brakes manipulated from the driver's cabin in augmentation of the ordinary brakes upon the eight wheels of the bogies. The system has not been adopted in the United Kingdom before. The generating plant consists of four Lancashire boilers of 150 H.P. each; five horizontal compound engines of over 100 H.P. each; and five (55) Kilo Watt dynamos of the Mather and Platt type, with Edison-Hopkinson magnets and Manchester armatures. Each dynamo is shunt wound for an electro-motor force of 550 volts at a speed of 800 revolutions per minute. The magnet limbs are of best selected well annealed cast steel. The magnet coils are wound upon separate spools removable from the limbs. The armature has Bessemer steel shaft, copper commutator insulated with mica. Sections are provided with two brushes on each rocking arm, each separately adjustable, with spring forward thrust and hold-off catch. The area of the cable is calculated on a basis of 1,000 ampères per square inch when loaded to the *maximum*. The accumulator station is fully equipped with an installation of 240 cells of patent chloride type. The generating plant is of sufficient power to work three or more cars, each loaded with 48 passengers, running at a speed of 8 or 8½ miles per hour under normal conditions of rails and weather. The overhead wire system has been adopted. These conductors consist of No. 0 Birmingham wire gauge, high-conductivity, hard-drawn copper wire, and are carried upon suitable insulators supported in clips attached to cross arms of steel poles between the rails. Each car has four No. 5a Manchester dynamo motors, two upon each bogie, one for each axle. These are geared with single-reduction steel, with pinion and wheel; and are fitted with Mather and Platt's patent carbon brushes. The driver's cabins, at each end of the car, have controller for stopping, starting, and reversing; with emergency switch, ammeter, and suitable resistances for regulating speed, and for stopping and starting.

The First-class Battleship "Prince George."—The *Times* gives the following description of this ship, which was recently launched from the Portsmouth yard. The principal dimensions of the ship are: Length between perpendiculars, 390 ft.; breadth, extreme, 75 ft.; mean draft of water, 27 ft. 6 in.; displacement when fully equipped, about 15,000 tons. She will be fitted with twin screws, each of which will be driven by an independent set of engines with three vertical cylinders and of 6,000 H.P., giving a total H.P. of 12,000 for both sets of engines, with a working pressure in the boilers of 150 lbs. per square inch, and an air pressure in the stokeholds equal to 1 in. of water. The amount of coal usually carried is 900 tons, but the vessel has a total stowage capacity of 2,220 tons. The disposition of her protective armor is similar to the *Majestic's*, the arrangements combining the advantages of the turtle-back deck of the cruisers with those of the citadel armor of the former battleships. The ammunition is also supplied to the guns through passages and trunks which are all either constructed of armor or are under protection of armor. The advantages gained by this arrangement over the unprotected broadside are obvious. The ship will be fitted with two masts, with two fighting tops on each. Each top will carry three 3-pdr. quick-firing guns, with the necessary magazines and equipment. Each mast will also carry on a platform at its head a powerful electric light for signalling and searching purposes. The *Prince George* will be fitted with the new 12-in. breech-loading steel and wire guns, which, though much lighter than the type fitted in previous battleships, will surpass them in power of penetration, and in consequence of their reduced weight will enable all fittings in connection with them to be reduced in size, rendering the whole of the machinery much lighter and easier to work, efficiency being thereby proportionately increased. These guns will be fitted in pairs in two armored redoubts, one at each end of the ship, and will be mounted on revolving turn-tables, the whole being worked either by hydraulic or hand power. These guns will be protected by an armor shield 10 in. thick, as in the *Majestic*, an advantage not possessed by previous battleships of this size. This vessel will also carry twelve 4-in. quick-firing guns, mounted in casemates, protected by 6-in. Harvey armor, eight of which are on the main deck and four on the upper deck. Each gun and its crew will thus be completely isolated from the others, orders being communicated from the central fighting station by means of a system of voice pipes. Sixteen 12-pdr. quick-firing guns will be also mounted on the main and upper decks, and the vessel's armament will be completed by the twelve 3-pdr. quick-firing guns in the military tops, by two 12-pdr. boat and field guns, and by eight .45 in. Maxim guns mounted in suitable positions; 22 torpedoes will be carried, which can be fired from four submerged tubes, two forward and two aft, and one above-water tube at the stern. Six search-light projectors, worked by three dynamos, each of 600 ampères, will be carried. Ten steam fans will be fitted for the purpose of ven-

tilating the working and living spaces, two for ventilation of the engine-rooms, and eight for furnishing the forced draft for the boilers. The vessel will have a complement of 757 officers and men.

A DEVICE OF VALUE TO INDICATOR-CARD TAKERS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

Mr. E. F. C. Davis, whose sad and sudden death was referred to in the September issue of this journal, was a man full of devices for overcoming mechanical difficulties and for smoothing rough roads in applying theory to practice in engineering. In the matter of the study of the steam-engine from the indicator card, he had a very extensive experience, and has taken personally about as many cards from locomotive engines as any man in the country, and to him the writer, as well as many others, is indebted for a very useful little suggestion pertaining to card-taking, which has proved to be a "friend in need" many times, and which will undoubtedly be appreciated by many readers of the AMERICAN ENGINEER.

We all concede that inaccurate data is frequently worse than none, and no engineer will acknowledge that he does not desire to know just what the engines in his charge are doing. The truth is that accurate and useful data is rare because, and only because, it takes time and trouble to obtain it, and few are willing to spare the one or endure the other unless pushed to it or paid for it.

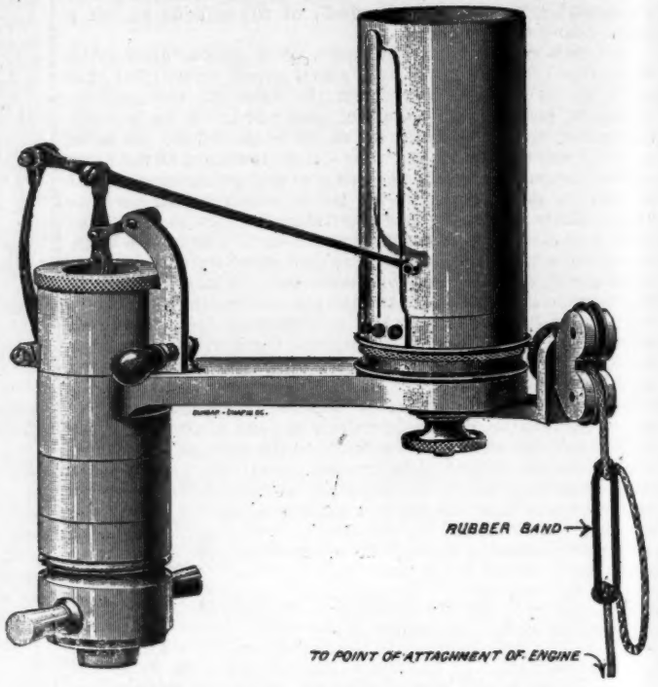
The indicator card, if properly and carefully taken, tells us much that we want to know, yet there are not many among those who use this method of obtaining information on the performance of engines who really appreciate the delicacy of the operation and the great importance of proper preparation. For instance, a heavy or light pressure of the pencil on the card will make the greatest difference in the resultant H.P., as well as give lines very misleading to the student of the card. The writer has frequently tested this, and has obtained successive cards from engines running at very uniform speed that varied as much as 10 per cent. in mean pressure, and that without any really excessive pencil pressure. The pencil must scarcely touch the surface, and good cards must necessarily be light ones. When it comes to taking cards from engines running at from 200 to 500 revolutions per minute, other difficulties arise, and it is mainly to these troubles that Mr. Davis's device is directed.

It is always desirable to obtain cards with but one or at least very few revolutions marked on them, and it is not necessary to have locomotive diagrams made with a broad race-track of pencil marks to average results from, as is generally the case. The principal cause of these multiple cards lies in the difficulty in taking off and putting on the cards while the engine is running, as the cord is liable to catch and break when running slack while the barrel is held still.

The manner in which Mr. Davis arranged the indicators is so simple and yet so thoroughly effective, that all who try it will always use it where more than a single card is desired, and as it is not a patent we will describe it here for "all comers." The accompanying figure will serve to show the method of adjustment.

The indicator used must, of course, be provided with a detent (or pall and ratchet) for holding the barrel at its fullest throw in order to change cards. The pencil must be fairly hard and ground to a "round," fine point, and not a sharp, cutting point. It must be adjusted by the screw-handle to just faintly bear on the card when held firmly against the stop, so that varying hand pressure does not enter into the conditions at all. The engine is turned so that the point which gives motion to the cord is at its fullest throw, then the cord is passed through the pulley on the indicator barrel and tied just below the pulley to one part of an ordinary rubber band $\frac{1}{4}$ in. wide and $2\frac{1}{2}$ in. long, this size suiting all ordinary indicators. The cord is then led to the point it is to get its motion from, and after pulling it until the card drum is within $\frac{1}{4}$ in. of its full throw it is secured to that point. The engine is now turned exactly one-half of a revolution, and the rubber band is stretched to 3 in. (about $\frac{1}{4}$ in. real stretch), and the point of the cord opposite the lower end of the stretched band is marked; the cord is now detached from the engine, and the last point marked is tied to the lower end of the rubber band, and the cord again secured to the engine just as at first. The apparatus is now ready for use; the detent is thrown in and the engine started. At each revolution the rubber band takes up all the slack and keeps a moderate tension on the cord, and whenever a card is taken or removed, and the detent thrown out or in, the action of the band takes up all sudden shock, and yet is too light to have any effect on the tension of the cord when the detent is out and the barrel spring working. In the illustration the detent is shown in gear and the throw of the indicator motion at its least distance from the indicator.

On locomotives a canvas dust-cover can be used over the indicator, and the apparatus kept in place during a long run without injury, so that a most valuable set of cards may be secured marking the different powers on heavy and light grades and at various speeds.



A DEVICE OF VALUE TO INDICATOR-CARD TAKERS.

For dynamo engines we know of nothing so well suited as is this appliance, and the cost of running these engines may be clearly shown by fair card. Roughly taken cards serve no purpose here, the points of cut-off and the lines of expansion being too indefinite to indicate leaky pistons, a source of loss more frequent in this kind of machinery than any other, and one which counts heavily in the coal bill.

A. A. W.

THE ACCURACY OF VALVE-GEARS.

To the Editor of THE AMERICAN ENGINEER:

It is a common remark of inventors and their friends in describing the claims of new valve-gears to say that they are mathematically correct, or that they give an excellent or nearly perfect distribution of steam. Mr. David Joy made such a claim in first describing his radial valve-gear (see Proceedings of the Institute of Mechanical Engineers, 1880, p. 425). He made a similar claim in his recent paper on his new hydrostatic single-eccentric gear before one of the engineering societies, as reported in the technical journals some two years ago. Regarding this later gear of his, he particularly mentioned, as a proof of its excellent accuracy, that the heat of the exhaust was beautifully regular, not at all like the irregular heat characterizing the common double-eccentric and expansion link gear. Alexander Morton, in his paper of 1882 before the Glasgow Society of Engineers, describing his radical gear (p. 8), claims that "*the motion of the slide-valve is mathematically alike in amount.*" Arrol and Pringle, in their British patent, No. 13,710, of November 11, 1885, for a single-eccentric gear, which I have lately been studying, make a similar assertion that their gear is mathematically correct.

Now what do such assertions and claims mean? Any one who has studied valve-gears by Zeuner's polar-circle diagram

and equations, knows well that for all gears controlled by any form of circular motion from the engine driving-shaft, the travel of the slide-valve from its mid-position is a function of the angle of the revolution of the crank—that is to say, neglecting the "*missing quantity*" and errors due to local disturbances of the gear by its various movements, the slide-valve opens, suppresses, exhausts, compresses, and opens again at equal angles on the crank path from either dead point, *not at equal points in the piston-stroke.* From the Zeuner standpoint, therefore, only a crank-path equality of angles can be termed mathematically correct. Of all the various valve gears invented, Arrol and Pringle's single sliding-eccentric gear alone gives an absolutely true polar-circle diagram, every stage of the valve movements being at equal angles on the crank-path from either dead point, and, to use Zeuner's term, there is no "*missing quantity.*"

Designers of valve-gear, however, never desire this sort of regularity. Their aim always is to produce equality of cut-off in the cylinder, tempered with a slight excess on the instroke sufficient to recoup loss of piston-rod area, or in vertical engines a slight excess on the lower side of the piston to partially balance its weight. Owing to the angularity of the connecting-rod the piston always travels farther on the outstroke than on the instroke for the same angle on the crank-path. Hence, any valve-gear deriving its motion from the driving-shaft will give a later cut-off on the outstroke than the instroke, unless it be specially adjusted to avoid this; in other words, to get equal work done on both sides of the piston every endeavor is made to prevent such gears from acting with "*mathematical correctness.*" Designers of locomotive valve-gear, while aiming at tempered equal cut-offs on the stroke, do certainly try to get the exhausts at equal angles on the crank-path, but this is for a wholly different reason—namely, to get a regular heat of the blast, as it is found that an irregular heat does not produce so good a smoke-box vacuum and needlessly tears the fire about. As the crank in a locomotive revolves at a constant speed, it is clear that to get a regular heat exhausts at equal crank-angles are necessary.

A TRAM-FASTENING.

To get the cut-offs equalized and tempered on the two strokes, all sorts of expedients are adopted for "*doctoring*" the gear, advantage being taken of local disturbances in the gear to set one off against the other, so as to produce the desired result. In link-motion work the moral maxim that two wrongs never make a right does not hold good. With this object the position of the reversing-shaft is shifted about, suspension links are made to swing away, eccentric-rods are made of unequal lengths, and unequal angles of advance given to the eccentrics. Probably the easiest and most fruitful doctoring is got by employing a rocking-shaft to drive the valve. By giving it a suitable location, the cut-off can be readily tempered as desired, and with equally good results for both fore and back gear. I am convinced that this useful property of the rocking-shaft explains its universal use on locomotives in America, where with steam-chests on top of the cylinders radial gears have made absolutely no way at all.

During the past quarter of a century I suppose I have read every book published in the English language treating of link-motions and valve-gears generally, and nothing has impressed me more than how that nearly all of them ignore the desirability or necessity for this doctoring of the gear, and devote pages of useless calculations and diagrams to proving the correct position of the reversing-shaft, length of reversing-arms, drag-links, etc. Zeuner set the example of this pernicious theorizing, but the professors generally have run greedily after him. It is safe, however, to say that not a single gear has ever been executed where engineers have adopted the theoretical proportions and locations for the various parts recommended by these excellent people.

On the other hand, I do not say that engineers are necessarily right in their insistence on the need for equalized cut-offs in the cylinder and all the dodging and doctoring of the gear which this entails. None, however, of the professors has had the courage to dispute this Will some of them now consider the matter and inform us exactly what is the gain in efficiency from securing cut-offs in the cylinder equalized on the stroke of the piston rather than on the crank-path? In other words, why should the work done on the two strokes of the piston be equal rather than that done through the two halves of the crank-path?

To clear the ground, I may point out that without the dodging and doctoring referred to, all valve-gears wholly operated by eccentrics or return cranks actuated by the driving-shaft, tend, when laid down in their simplest and most theoretically dictated forms, to give valve movements equalized on the crank-path. All single and double-eccentric link-motion gears come in this class. All radial valve-gears, where the port opening movement is obtained by a return crank or eccentric (such as Von Hensinger's gear, several forms of Morton's gear, and one form of Joy's gear), also tend to give valve movements equalized on the crank-path and form one class with the above. Only those radial gears where the port-opening movement is obtained from the to and fro motion of the cross-head tend (so far as local disturbances of the gear may permit) to give valve movements equalized on the stroke of piston. The marine form of Morton's gear and a few other lesser known gears of similar class fulfil this condition. These forms of radial gear where the port-opening movement is obtained from the to and fro motion of the same point in the connecting-rod, which by its vibratory motion gives the lead of valve (such as Joy's best known form of gear), lie midway in performance between the two classes above named. The nearer the point taken in the connecting-rod is to the cross-head, the nearer they approach the second class, and *vice versa.* Will any of your readers now say which of the two classes undoctored is the better?

In conclusion, while on this subject I may draw attention to the very common, not to say general, assertion (often assumption) made by all sorts of writers, that radial gears are superior to link-motions in giving a later exhaust with less compression. Joy asserted this of his gear, claiming that he could work in marine engines with a single slide-valve only, where before with link-gear a separate expansion valve was necessary (see Proceedings of the Institute of Mechanical Engineers, 1880, p. 428). Such a claim is not according to fact. No greater improvement in that respect is obtainable by employing a radial gear than by employing a link gear properly proportioned and sufficiently doctored. From experiments with full-sized model boards with two different gears operated together, I can assert that for all practical purposes radial gears and link gears, designed for the same engine with same lap and tend, act identically, and the valves operated by both move synchronously. DIGNA SEQUAMUR.

INSEIN, LOWER BURMA, August 1, 1895.

TRAM-FASTENINGS.

Editor AMERICAN ENGINEER:

Noting your remarks on the Alteneder beam-compass in last month's issue, I wish to say that your first views were not far out of the way. The necessity of making a special beam is a nuisance, as it is no easy thing to make a rabbet in a long, thin piece of wood and have it straight. Some years ago I made a little piece of German silver, as per sketch, which avoided this. Several of my friends have adopted this and find it very convenient, as any carpenter can very quickly furnish them with a plain stick. I like Alteneder's work *very* much, particularly his new pen, with which I would not part.

BOSTON, MASS. ALBERT F. HALL.

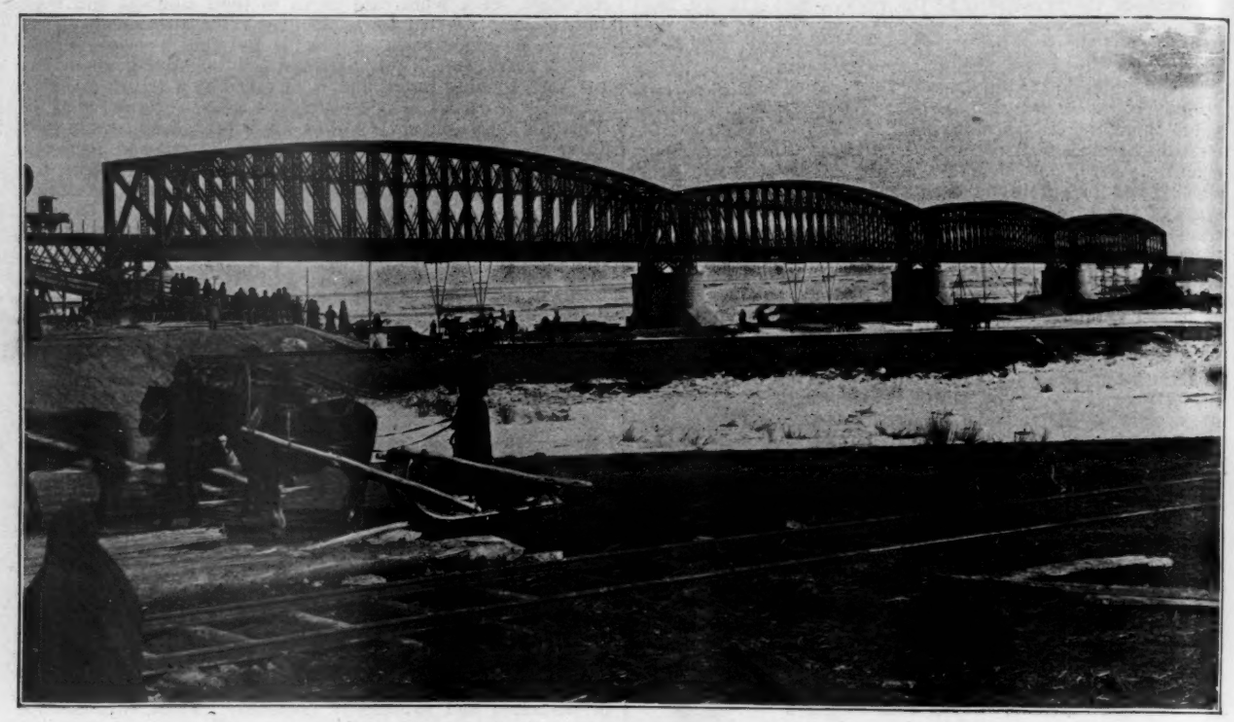
THE GREAT SIBERIAN RAILROAD.

THE new Russian Minister of Ways of Communication, Prince Khilkov, in the matter of the construction of the Siberian Railroad, evidently will not endorse the acts of his predecessor. The delay in construction of the South Oussouri line, its excessive cost and the uncertainty in the estimates of the Central Siberian Railroad and of new lines, have suggested to him the idea of sending to Siberia a special commission for studying the conditions of the construction of the Siberian Railroad.

In the twenty-second session (March 8/20, 1895) of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, and presided over by the Emperor Nicholas, the Minister of Ways of Communication proposed, in order to study the present condition of the works of the Siberian line upon the spot, and its future prospects, to send to Siberia a special temporary commission, presided over by the Vice-Minister, General Petrov, and consisting of seven engineers and four persons of other specialties.

The organization of this temporary commission was approved, and 100,000 roubles were appropriated for its expenses.

At the same session the Minister of Finance brought up the question of a commercial harbor in Vladivostok, and suggested



THE TOBOL BRIDGE AT THE TIME OF TESTING, 1895.

CONSTRUCTION OF THE ISHIM BRIDGE. SINKING OF THE FIRST CAISSON AND THE TEMPORARY BRIDGE.

the necessity of examining the place. For the purpose of this survey and location 20,000 roubles were appropriated.

A credit of 346,200 roubles for the 30 mail cars to be ordered for the Western Siberian and the Central Siberian Railroad (from Chelabinsk to Irkoutsk) was intended.

The twenty-third session of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, presided over by the Emperor Nicholas, was occupied with the new rules for facilitating the work of exiles and prisoners on the construction of the Siberian Railroad and the new staff of police in the region of the works of the Oussouri line.

A great many prisoners have already worked on the construction of the Oussouri and Central Siberian lines, and the results obtained on the latter are quite satisfactory. The prisoners worked on the grading on Irkoutsk section (516 men) and on Krasnoïarsk section (435 men), and moved about 5 cub. yds. per day, earning about 50 cents a day.

In the same session (May 3/15, 1895) the instructions to the Commission for studying the construction of the Siberian Railroad were confirmed.

According to these instruction, the Commission—presided over by the Vice-Minister—consists of 13 members: seven from the Ministry of Ways of Communication, two from the State Comptrol, one from the Ministry of Finance, one from the Ministry of Interior, one from the Ministry of Agriculture, and one member—secretary. A supplementary member from the Ministry of War will be appointed by the Chief of Oussouri War District.

The Commission will consider the following questions: (*a*) The present state of the works of construction of the Siberian Railroad; (*b*) the suitableness of the means employed for the construction; (*c*) the future plan for the most successful and profitable mode of construction verified on the spot; (*d*) the possibility of finishing the works in the proposed time; (*e*) the sufficiency of preliminary estimates.

As a technical body, the Commission inspects all the constructions already finished and still in progress—viz., grading, track, bridges, etc., and also the state of the rolling stock.

The financial duty of the Commission consists in studying the means for furnishing the materials, in examining the contracts and the liability of contractors, ascertaining whether money is spent with proper economy, and in the end in ascertaining why the cost of construction of the Oussouri line has surpassed the preliminary estimates.

The Commission, as an administrative body, will have in view the furnishing of workmen for the construction, it will elucidate the question of possibility or necessity of using the strangers and foreigners and the prisoners. It will decide whether the population is sufficient for the future support of the railroad.

Besides these subjects, the Commission will study the waterways in connection with the construction of the Siberian Railroad, and the means for the development of the iron works.

The Commission left St. Petersburg at the end of May and divided into two parties, one of which has gone by land to Irkoutsk, and the other by ocean to Vladivostok. Both parties will meet in Irkoutsk, and will there work on the new estimates of the Central Siberian & Transbaïkal line, and at the end of August will return through Omsk and Chelabinsk to St. Petersburg.

The twenty-fourth session (June 28/ July 10, 1895) of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, and presided over by the Emperor Nicholas, was occupied by the appointment of a new staff of police in the region of Transbaïkal Railroad, the organization of the work of prisoners in the Tomsk Government (Central Siberian Railroad), and the question of the harbor of Vladivostok.

The use of prisoners in the construction of the Siberian Railroad has been much increased. At present 1,450 prisoners and exiles work on the North Oussouri line (the extension of the South Oussouri line). Four parties of prisoners, 150 men each, work on the Transbaïkal line.

The use of prisoners has been extended also on the Tomsk Government, and will greatly facilitate the construction of the Central Siberian Railroad.

In the vicinity of the line there are the Nicholas Iron Works, leased by Mr. Glotow, who contracted for that line 1,000,000 poods (16,000 tons) rails, at the price of 2 roubles a pood ($60 a ton). The contractor has also received 300,000 roubles as a government loan for the development of the works.

The Vladivostok harbor will be constructed in the Bay of Golden Corn. Its length will be 1,540 ft., and the depth 26 ft. The general cost is estimated at 500,000 roubles ($250,000).

In the same session—July 10, 1895—the following general data about the state of construction were presented:

The track is already laid on the first division of the Western Siberian Railroad, from Chelabinsk to Omsk (500 miles), and 200 miles on its second division;* 143 miles on the Central Siberian Railroad, 251 on the South Oussouri line, and 10 miles in the North Oussouri line; total, 1,104 miles, or about one-quarter of the whole Siberian Railroad.

The earthworks on the first division of the Western Siberia Railroad are finished; on the second division 88 per cent. is made; on the first division of the Central Siberian Railroad, 52.4 per cent.; on the second division, 5.4 per cent.; on the North Oussouri Railroad, 18.3 per cent.; on the Ekaterinbourg branch, 32 per cent.; and on the Transbaïkal line 240,000 cub. yds. are already in place. The number of workmen was quite sufficient in the summer of 1895—viz., on the Western Siberian and Central Siberian, the Transbaïkal and Oussouri railroads the number of men was: 32,639 engaged on earthworks, 13,080 wheelbarrow men (with horses), 5,851 track-layers, 4,370 carpenters, 4,096 masons, 2,099 smiths, a. s. o.—total, 62,135 workmen. Besides on the Ekaterinbourg branch 8,090 workmen, and in all 70,225 men.

For the construction of the Great Siberian Railroad up to January 1, 85,517,551 roubles have been appropriated, of which 73,437,112 roubles have been expended, leaving 12,080,439 roubles.

The surveys of the Amour line were begun in 1894, and have been continued this year.

The survey of the Amour territory, made in 1894, has shown that this country presents a marshy plateau often inundated. The settlements are very scarce. The surveyor has noted only 15. The places suitable for settlement are the following: (1) between the Shouki and Ouldoura mountains and rivers First Shouki and Small Bira; (2) along the river Great Bira, between Stoïby and Kroutoï Yar; (3) south from the river Ourmi, and westerly from Teklin; and (4) between the Great and Small Chourki mountains. In all these places the soil is fertile, wood is abundant, and water is good.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XVII.—METHOD OF DETERMINING SPECIFIC GRAVITY OF OILS AND OTHER LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1891, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 333.)

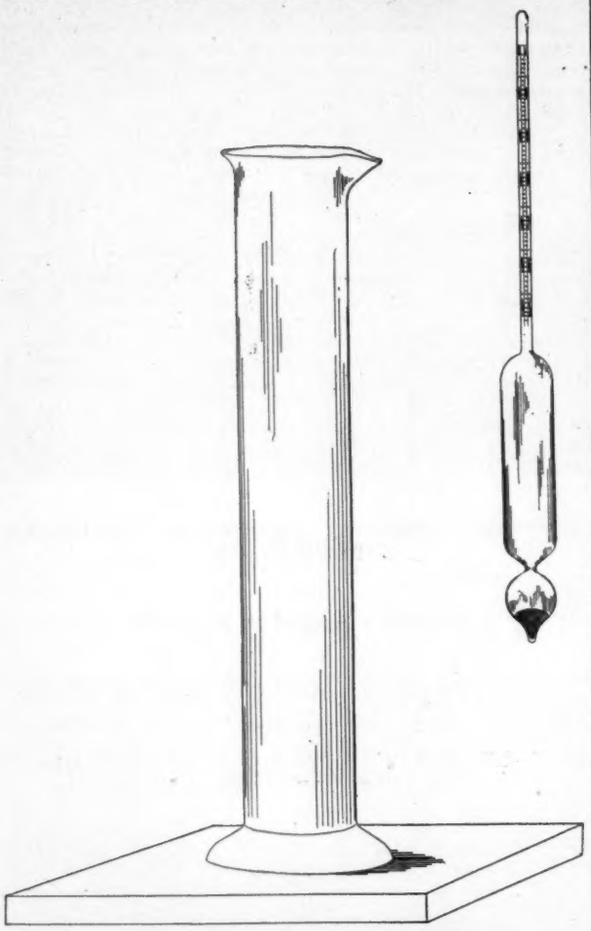
Three different methods are used for determining the specific gravity of oils and other liquids, as follows: I. By means of the hydrometer. II. By means of the Westphal balance. III. By weighing any known volume of the liquid in question, and comparing this weight with the weight of the same volume of water.

OPERATION.

I. When using the hydrometer—applicable to all liquids, whether transparent or not, except such as are too viscous—fill the hydrometer jar to a convenient height with the liquid to be tested, introduce the hydrometer, and alongside of it a delicate thermometer sufficiently long to reach to the bottom of the jar, and be used as a stirring rod. Stir with the thermometer, disregarding the hydrometer for the moment, and taking pains to have the thermometer reach to the bottom of the liquid, until the reading of the thermometer becomes constant. Read the thermometer and withdraw it from the liquid. Raise the hydrometer and wipe the stem clean, nearly down to the bulb, then carefully allow it to sink in the liquid.

* The track is now laid on the whole Western Siberian Railroad.

This operation must be managed so that the stem of the hydrometer will not be wetted above the point corresponding to the gravity of the liquid. Read now the mark on the stem corresponding to the level of the liquid. The reading of the hydrometer is the specific gravity, or the degree of Beaumé's or Twaddle's, or whatever scale the hydrometer is graduated in, corresponding to that temperature, and this reading when corrected for temperature, as provided under "calculations," becomes the reading to be used. The method described above is that applicable to the petroleum products. When other liquids are tested with the hydrometer, if no tables corresponding to those described under "calculations" have been prepared, the temperature must be made 60° F. before reading the hydrometer, and no corrections are necessary.



HYDROMETER AND HYDROMETER JAR.

II. When using the Westphal balance—applicable to all liquids, except such as are too viscous, but works best with transparent liquids—set up the balance on a level place, by placing the beam in position and hanging the plummet on the hook provided for it. Now adjust with the adjusting screw in the foot until the pointers are exactly opposite each other, cool the liquid to be tested to a point a little lower than that at which the balance was graduated, fill the jar with enough of the liquid, to a little more than cover the plummet, and place the jar in position. Allow the temperature of the liquid to raise with occasional stirring, until the reading of the thermometer in the plummet is that at which the balance was graduated. Now hang the weights on the beam at the notches provided for them, until the pointers are again exactly opposite each other. If two belong on the same notch, hang the second on the hook of the first. Read the marks on the beam where the weights hang, and set down the figures by the side of each other, putting the figure under the heaviest weight at the left hand, that under the next heaviest, next, and so on. The result will be the specific gravity expressed in decimals when the liquid is lighter than water. For liquids heavier than water it will be found that one of the heaviest weights will hang on the hook along with the plummet, the others being distributed along the beam. The reading of the heaviest weight will then be 1, which must be followed by a decimal point, the other readings following the order of the size of the weights, as above described, being placed after this decimal point. In case the specific gravity of the liquid in question is 2 or above, or 3 or above, two or three of the heaviest weights, as the case may be, will hang on the hook, the others being distributed along the beam. When the liquid to be tested is opaque, so that the reading of the thermometer in the plummet cannot be made, it is essential to have an additional thermometer to use in determining the temperature. This additional thermometer should, of course, be compared with the one in the plummet.

III. When weighing a known volume of the liquid and comparing it with the weight of the same volume of water—applicable to all liquids—weigh any convenient graduated vessel with a thermometer in it, cool the liquid to be tested to a temperature a little below 60° F., pour into the weighed graduate any convenient measurable amount and weigh. Clean the graduate and repeat the operation with distilled water, using the same volume as before. The ratio of the two weights, using the weight of the water as divisor, is the specific gravity of the liquid.

APPARATUS AND REAGENTS.

The cut shows the hydrometer and hydrometer jar with perhaps sufficient clearness, so that further explanations are unnecessary. The hydrometers usually used with oils are graduated with Beaumé's scale, although they may readily be obtained in the market, with Beaumé's and specific gravity scales on the same instrument. For use with oils they should be graduated to a tenth of a degree Beaumé. There is some difficulty in reading hydrometers, especially with opaque liquids, due to the semi-meniscus of the liquid adhering to the stem. When the hydrometer is graduated to tenths of a degree, it is probable the reading may be in error a corresponding amount. If greater accuracy is desired, hydrometers with much finer graduations must be used, or one of the other methods employed.

The Westphal balance is usually now constructed with a plummet weighing 5 grams, and occupying the space of 5 cub. centimetres. These are called Reinman's. The beam is graduated into 10 equal divisions, and the heaviest weight weighs 5 grams. The next size weight weighs a tenth of this, the next, a hundredth, and the smallest a thousandth. The balance being adjusted in air, so that the pointers are exactly opposite, if the plummet is immersed in distilled water at 15° C., the heaviest weight being placed on the hook with the plummet should bring the pointers opposite each other again.

The choice of a vessel to be used in weighing equal volumes of any liquid to be tested and water depends on the balance used. If a delicate chemist's balance is employed, a small flask with mark on it is applicable. If a coarser balance is used, a larger vessel should be employed. Specific gravity bottles, both with and without thermometers, and appliances for securing equal volumes of the liquid to be tested and water, may be obtained in the market. When the method is used with moderately viscous liquids, care should be taken not to use apparatus with too small a neck, on account of difficulty in filling, and in view of the difficulty of accurately measuring viscous opaque liquids, it is advisable to employ as large volumes of liquid as the balance will allow.

CALCULATIONS.

When the hydrometer is used in oils, unless the temperature happens to be 60° F., a correction must be made. It is generally agreed that for this purpose Tagliabue's "Manual for Inspectors of Coal Oil" shall be used. This manual shows in tabular form for every degree of Beaumé's scale, for liquids lighter than water, from 20 to 100, and for every degree of temperature from 20° to 109° F. the corrected gravity. It has also a comparison of Beaumé's scale with the specific gravity, both for liquids lighter and heavier than water. The method of using the tables is given in the manual. When using the Westphal balance, the readings are obtained direct, and no calculations or corrections are needed. The method of getting the gravity when weighing equal volumes of the liquid to be tested and water is given under "operation."

NOTES AND PRECAUTIONS.

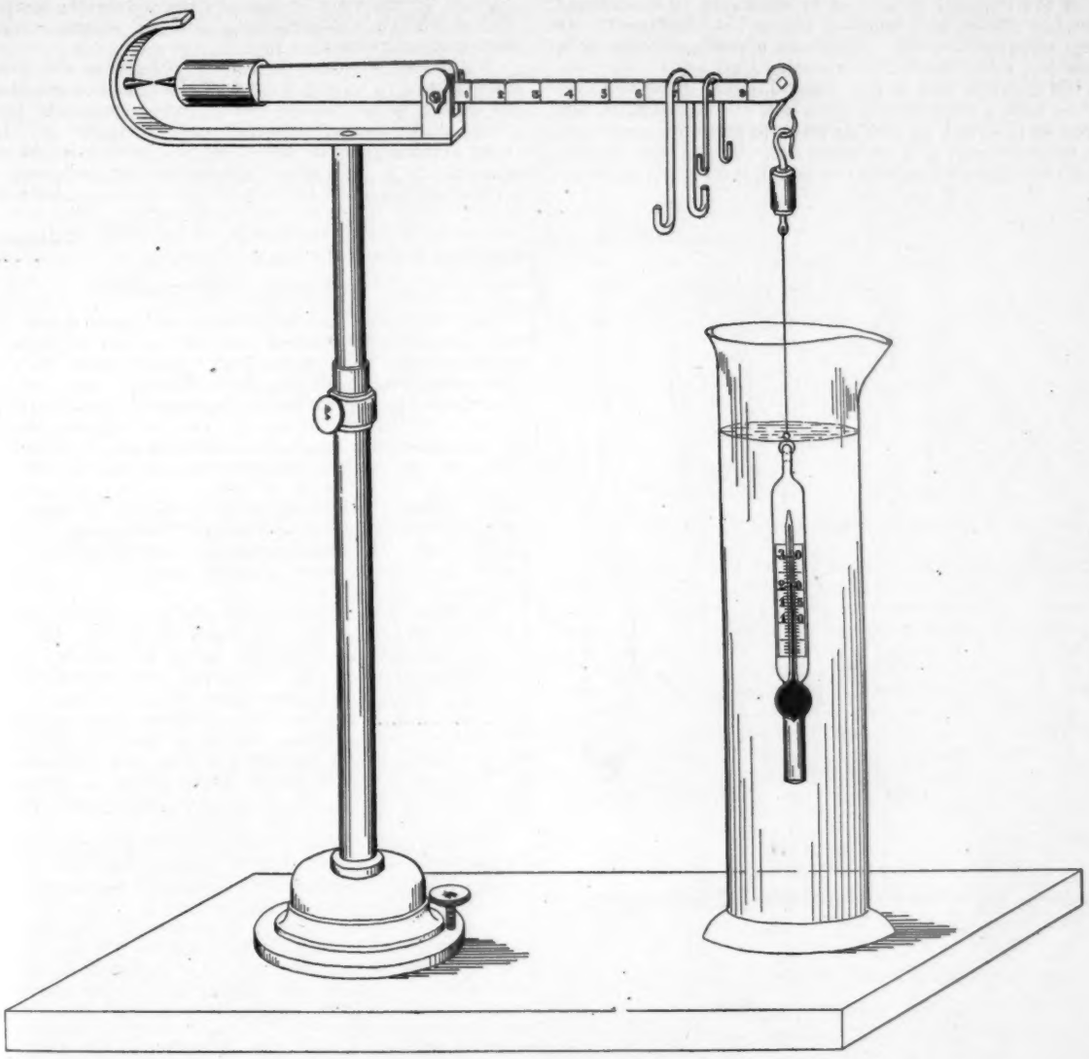
The principles involved in the methods of determining specific gravity, described above, are perhaps too well known to need comment or explanation.

The hydrometer is principally used with petroleum products, the Westphal balance with spirits of turpentine and other transparent liquids, and the method of weighing equal volumes of the liquid to be tested and water with liquids that are too viscous for the other two methods. The Westphal balance is also useful in taking the gravity of standard

solutions and acids, and sometimes when a vegetable or animal oil is suspected of adulteration.

With all liquids which are transferred from one vessel to another, there is always possibility of air being mechanically carried along with the liquid. Usually with petroleum products there is very little difficulty from this cause, since the air escapes readily from those which are sufficiently limpid. Petroleum products which are viscous must be warmed or heated sufficiently to allow the air to escape, whichever of the three methods of determining the gravity is employed, and of course when the Westphal balance or the weighing method is used they must be cooled again before the gravity is taken. The temperature should not, however, reach the vaporizing point of the oil. With transparent liquids, when the bubbles of air can be seen, especially if they adhere to the sides of the jar, slow stirring frequently serves to remove them. Allowing the liquid to stand quietly for some time in the hydrometer jar also serves to free the liquid from bubbles. Of course neither the hydrometer or the plummet of the Westphal balance should be introduced into the liquid until the bubbles of air have escaped or been removed, on account of the danger of some of the bubbles adhering to them, and thus leading to erroneous results. Of course also the weighing method gives erroneous results if any bubbles of air are in either liquid when they are weighed. In testing commercial products to which only these methods are supposed to be applicable, no attempt is made to remove dissolved air or other gases.

There does not seem to be universal agreement as to the temperature at which the weight of the water used as divisor should be taken. Some authorities think the weight of water employed should be that at its maximum density, others that at 60° F. It is assumed in the methods described above that the hydrometers are made so as to be accurate at 60° F., whether used in water or other liquids, that the Westphal balance under the same conditions is accurate at 15° C., and that when the liquid to be tested and water are weighed, they are both weighed at 60° F.



THE WESTPHAL BALANCE.

Many of the hydrometers in the market are carelessly made. It is not rare to find them 1° or even 2° Beaumé in error. All hydrometers before use should either be checked in accordance with the principles of their construction or compared with reliable standard hydrometers.

AN EXAMPLE OF WHEEL CONSTRUCTION.

DESIGNED BY E. S. COBB, M.E., SAN FRANCISCO.

ONE would suppose, from the universal use of wheels of all kinds, and the careful attention that has been given to the properties and disposition of materials in their construction, that the art had reached the ultimate, but some study of the example here given will, if we mistake not, disclose new features of interest.

The failure of large wheels during five years past forms a long list of serious casualties, showing that the increased rate of rotation demanded in modern practice has not been met by the conditions of construction. At the same time every one knows that the physical properties of common material provides strength far in excess of any demands that working conditions should impose.

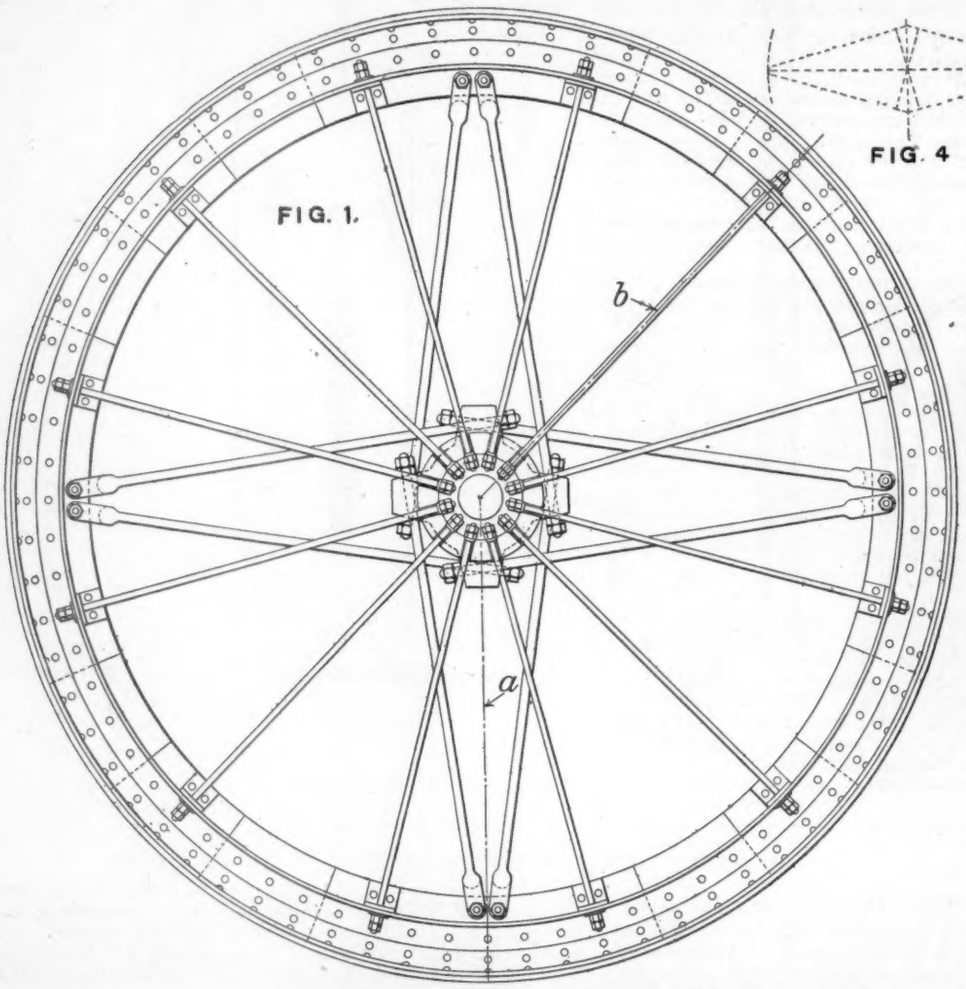
Mr. E. S. Cobb, of San Francisco, was called upon some time ago to design a large tangential wheel, 17 ft. 4 in. in diameter, with a limit of weight and cost, and a guarantee of strength and stability, that led him to consider carefully the various methods of constructing large wheels, with the result that he has produced a structure in which all the strains are tensile, and all simple in respect to each member, so the whole value of the material is utilized in resistance to centrifugal and driving forces, and bending strains are eliminated. At the same time the sections throughout correspond to those in common use, rolled from fibrous iron or steel.

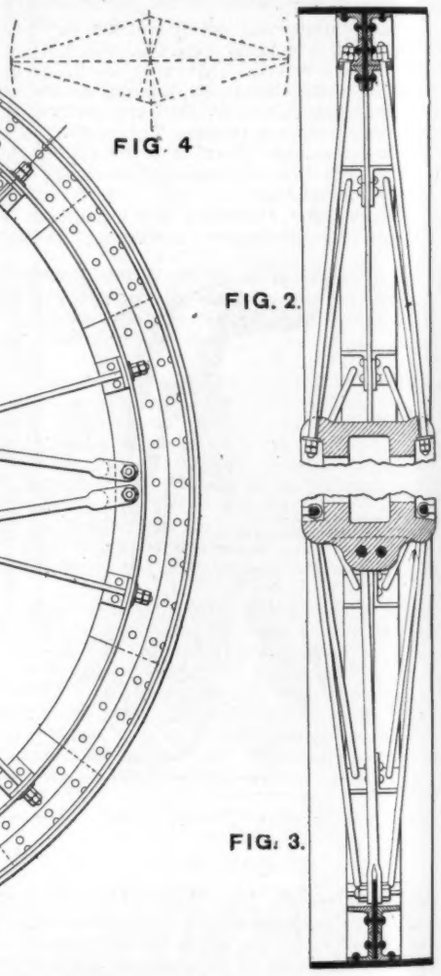
The rim sections, seen in figs. 2 and 3, are composed of four angle-iron bars, a radial centre plate, and a covering band, but these can be modified in various ways to receive toothed segments, rope grooves, or a fly-wheel rim. The present design, for which dimensions are given further on, is for a driving band-wheel.

Mr. Cobb sends the following particulars of the wheel shown in the drawings:

FLY WHEEL FOR AN ENGINE 400 to 500 H.P.

Diameter over all	18 ft.	2⅛ in.
Width of face		30 in.
Diameter of shaft		10 in.
Length of hub, bore		22 in.
" " " over all		32 in.
Center to centre of spokes laterally at the hub		26 in.
" " " " truss rods at the hub		32 in.
Diameter of radial spokes		1¼ in.
" " truss rods		2 in.
Weight of rims	11,500 lbs.	
" " spokes	2,000 lbs.	
" " hub	3,300 lbs.	
Total weight of wheel	16,800 lbs.	
Weight of rim per ft.	210 lbs.	
Radius of rim, average	8.58 ft.	





FLY-WHEEL FOR 500 H.P. ENGINE, DESIGNED BY MR. E. S. COBB.

By examining the disposition of the various members it will be seen that when the wheel is in motion, all of its members are in tension, except one chord of the driving trusses, of which there are two.

The radial rim-supporting spokes have no function except to sustain the rim and resist centrifugal strain. These spokes are made adjustable, so as to set the rim true and concentric, and are removable separately without disturbing other members.

The turning strain on the driving truss-rods will be understood by the diagram fig. 4, showing the lines of force, the disposition of the parts constituting a symmetrical beam to resist or impart strain about its axis, or to the shaft on which the wheel is mounted. The provision for lateral stability is ample, as will be seen in the sections. Fig. 2 is taken on the line *b*, and fig. 3 on the line *a* of fig. 1.

It will also be seen that this construction affords convenient means of adjusting the rim laterally, also for rotundity, and setting it concentric with the axis or shaft.

At 120 revolutions per minute the whole of the centrifugal force could be sustained by the radial spokes, 24 in number, with a tensile stress of 11,130 lbs. per inch of section. The rim taken at 75 per cent. of its actual section when sustaining the whole centrifugal strain at the same speed would only be subjected to 1,244 lbs. per inch of section, and these two members combined, made of merchantable steel, will show a resisting value up to a rim velocity exceeding 30,000 ft. per minute, far beyond any possible condition of use, or even of accident.

There is also furnished some computed data respecting cast-iron wheels for comparison. This we omit, believing there is no *known* value for cast material in wheels. We have only what is derived from observed results, and calculated values are of little use.

Mr. Cobb is arranging tables of reference for the various components in wheels of this kind, and is prepared to furnish designs, weights, and estimates for wheels of all sizes and strength based upon the methods of construction that have been described.

THE LAVAL STEAM TURBINE.*

By M. K. Sosnowski.

(*Continued from page 407.*)

Instead of utilizing the pressure of the steam M. de Laval conceived the idea, which is far in advance of the other solutions that we have just pointed out, of allowing the steam to expand and thus acquire a velocity that is dependent upon the pressure of the medium in which it acts, and then of utilizing this kinetic energy in a mechanism similar to hydraulic turbines, by communicating thereto a certain amount of its motion by a continuous modification of the direction of the relative velocity and a gradual reduction of the absolute velocity.

THE PRINCIPLE OF THE LAVAL TURBINE.

The fundamental principle of this turbine is that high-pressure steam is entirely expanded when it strikes the wings of the driving-wheel. This expansion takes place in distributers, and the steam therein acquires an active force which is equal to the work that it would have performed while slowly expanding behind a piston. This active force is alone utilized in this machine. Now, the density of the expanded fluid being very low, the principal factor of this active force or *vis viva* is velocity.

Steam under a pressure flowing into the air from an orifice of small section acquires a considerable velocity, which may

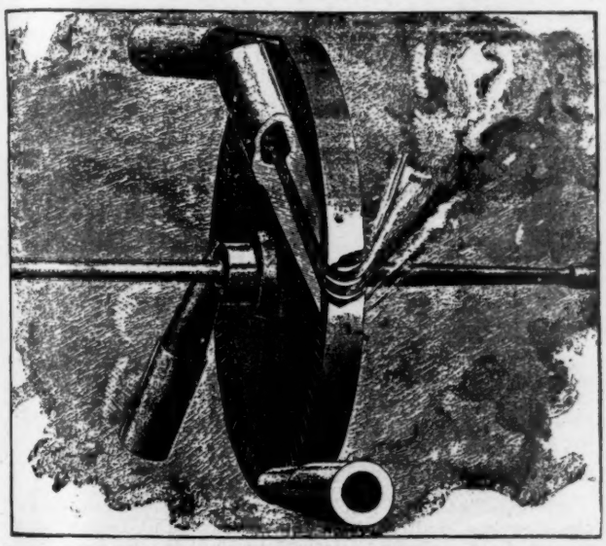


Fig. 14.—PERSPECTIVE VIEW OF THE TURBINE WITH BUCKETS SHOWING THE PASSAGES FOR THE ADMISSION OF STEAM.

even be as high as 2,400 ft. per second at a pressure of 60 lbs. per square inch in the boiler, and 2,925 ft. when the pressure is 150 lbs. If the pressure of the medium into which the escape takes place does not exceed 1.5 lbs., these velocities rise to 3,510 ft. and 3,900 ft. respectively. The velocity of the steam as it leaves the distributers thus being enormous, the same condition must obtain with the rotative speed of the wheel which turns at the rate of from 8,000 to 30,000 revolutions per minute, with a linear velocity that varies from 575 to 1,300 ft. per second.

A great deal of work can thus be communicated to the shaft of a wheel whose details are small. In fact, the tangential strain is insignificant upon a circumference of 2¼ in. radius; at 400 revolutions per second it does not exceed 5,600 lbs. per square inch when the machine is producing 10 H.P.; hence, these turbines are very small as compared with the power that they develop (about 19.7 in. for 200 H.P.), and the shafts are light.

DESCRIPTION OF THE LAVAL TURBINE.

The Laval turbine is similar to the hydraulic turbine in the partial introduction and free escape. It is composed of a wheel with wings or buckets (fig. 14), against which the perfectly expanded steam is led by one or more conical openings, whose axis is slightly inclined to the plane of the wheel. These jets of steam enter the conduits and glide over the wings by virtue of the relative velocity and communicate to the latter the *vis viva* of the steam. This steam passes out at the opposite side with an absolute velocity which it is sought to render as low as possible by giving the best possible contour to the wings.

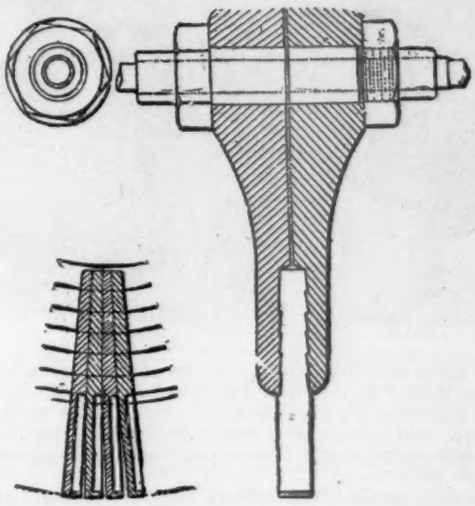


Fig. 15.—TURBINE WITH SEPARATE BUCKETS.

The body of the turbine is mounted upon a steel shaft (fig. 16) which rests in two boxes at its ends, and the whole turns in a chamber (fig. 17), which is provided with the openings *a* into which the outlet for the distributers is fastened. At one end of the shaft there is a regulator (fig. 18), the details of which are shown in fig. 19, that acts by means of a lever upon a balanced safety-valve, placed at the point where the steam enters the turbine. A train of gears (3 on fig. 16 and fig. 20) completes the make-up of the motor, and reduces the speed of the turbine in such a ratio as may be desired.

The Steam Distributers.—This important part causes the steam to be perfectly expanded before it reaches the wings.

Fig. 16.—PINION, SHAFT AND TURBINE.

Its section is of such a shape that the velocity of the jet is increased as much as possible. The final section should be such that the fluid shall have acquired a density corresponding to the medium in which the turbine is working. These openings can be controlled by means of butterfly valves which are placed in the steam passages; so that it is readily understood that by this means the power can be easily regulated, since each opening may be made to act practically independently, and the efficiency be kept at a high point.

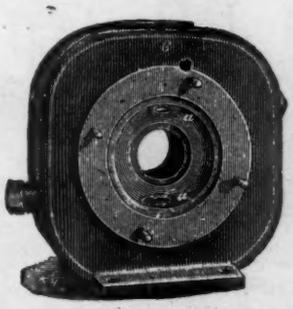


Fig. 17.—THE CHAMBER.

The Wheel Proper.—The wheel of the turbine is made of steel of the very best quality; the wings are cut from the solid metal on the periphery, and a band of steel is then forced on over the tubes (fig. 14). This band prevents the escape of steam from the ends of the wings; it also does away with the prejudicial resistance that would otherwise be set up between the surrounding atmosphere which is at rest. These wings can also be made separately, and then put together, as shown in fig. 15.

The Flexible Shaft (4, fig. 16).—It is a certain thing that whatever precautions may be taken in the making of the wheel, it is almost impossible to produce one wherein the centre of gravity shall coincide with the geometrical axis of

* Paper read before the Society of Civil Engineers of France.

the shaft and at the same time have its plane of symmetry perpendicular thereto.

As the wheel has a high angular velocity, the effect of the centrifugal force would become considerable. For each ounce placed on the periphery of a wheel 7 in. in diameter and making 24,000 revolutions per minute, the centrifugal force amounts to 140 lbs., the principal effect of which with

FIG. 18.—THE REGULATOR.

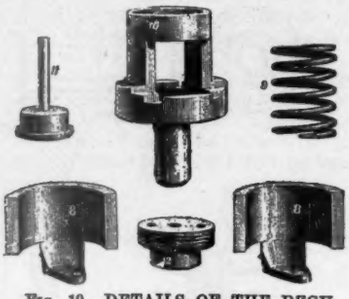


FIG. 19.—DETAILS OF THE REGULATOR.

rigid shafts would be heating in the bearings and a breakage of the shaft. M. de Laval has overcome this difficulty in a very ingenious manner and with entire success, by utilizing the gyrostatic properties of bodies and by mounting his wheel in a certain way upon a very small, and consequently very flexible shaft.

If a body which is symmetrical about an axis held at its extremities and passing through the centre of gravity is made to revolve, it will tend, as its velocity is increased, to turn about its axis of principal inertia, which is the line perpendicular to the plane and passing through the centre of gravity. The physical axis being flexible will take on the deformation necessary to permit of this adjustment, as shown in fig. 23. The position of the disk which, for the sake of simplicity, we have taken as an example, is a matter of no moment. This disk may be at the centre of the axis, as in fig. 23, at a distance of one-third from one end, as in fig. 24, or one-quarter, as in fig. 25. The vibratory motion of the shaft alone will be changed. If, on the other hand, we cause a disk to turn about a flexible shaft that is at right angles to its plane of symmetry, but does not pass through the centre of gravity, we will have two different cases:

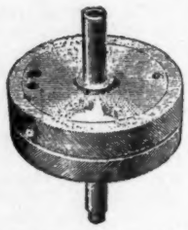


FIG. 20.—THE GEAR.

1. The disk being placed in the centre of the shaft between the two fixed points, the centre of gravity will tend to move out as far as possible, and this tendency will increase as the speed increases (fig. 26, a' a'').

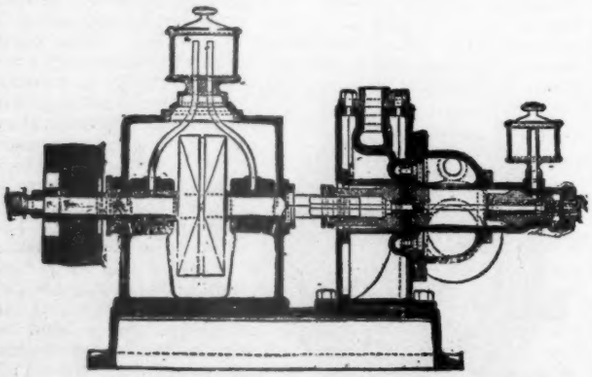


FIG. 21.—LONGITUDINAL SECTION OF THE TURBINE.

2 If the disk is not at the centre of the shaft, the latter will commence by bending; but then the plane of symmetry of the disk will become inclined to the geometrical axis, and, as the speed increases, will tend to adjust itself perpendicularly to this axis, and thus bring the shaft back into true alignment with its bearings.

In point of fact, the shafts of the Laval turbines are made of steel of very small diameters; the bearings are very long; they rest in bronze boxes with linings of anti-friction metal, with a moderate but continuous amount of lubrication, so that all binding is avoided.

Regulation of Speed.—The several pieces of the regulator are shown in fig. 19. Their operation is as follows: The bases of the regulator formed by the two half cylinders (8) are pivoted upon the shell (10), and the lugs that serve as the base for these half cylinders rest against the head of a point (11)

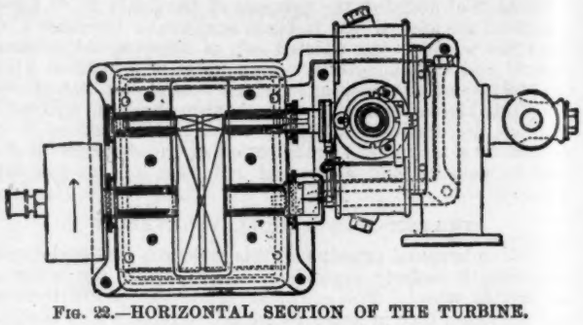


FIG. 22.—HORIZONTAL SECTION OF THE TURBINE.

that acts through a lever upon the admission valve. The point (11) is held by a resisting spring (9) inclosed in the shell by means of a screw (12). The regulator acts upon the admission valve and insures a perfect regulation of the machine regardless of the load.

Furthermore, the steam on leaving this valve is divided so as to pass through several conduits, 4, 6, 8, according to the machines. The valves can be operated from the outside of the machine by means of hand valves which permit the maximum power of the machine to be reduced by a half, a third, a quarter, etc., while the excellent conditions of economical action

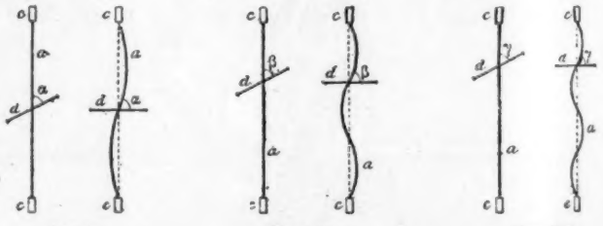


FIG. 23. FIG. 24. FIG. 25.

are still preserved. The result is that a given machine consumes about the same amount of steam per H.P. when working at one-half, a third, or a quarter of its normal power.

APPLICATIONS.

Motors.—The Laval turbine can be used to replace ordinary steam-engines in all of their applications. Fig. 28 represents the whole of a motor of from 5 to 50 H.P. Starting from this size, the turbines have twin motor shafts, and consequently two controlling pulleys. The speed of the turbine always being very great relatively to the machine to be driven, all of the machines are provided with an auxiliary shaft that is connected to the main shaft by means of a pinion (fig. 16) and a gear (fig. 20).

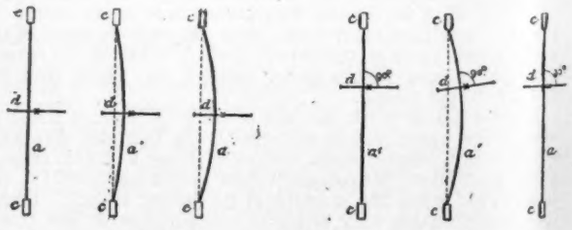


FIG. 26. FIG. 27.

Figs. 21 and 22 represent two sections of turbines. Fig. 32 shows a practical application; the speed of the driven shaft is 480, while that of the pulley on the turbine is 3,000 revolutions per minute.

Fig. 33 illustrates a motor with twin shafts, such as is used on turbines of more than 50 H.P. This turbine has two grooved pulleys for a rope transmission. The cable is kept taut by a special idler shown in the engraving.

Dynamo Turbines.—When a dynamo is to be driven by a turbine we can couple them direct. Figs. 29 and 30 show some simple generators that are coupled in that way. Fig. 31 represents a turbine dynamo with two shafts, as indicated for

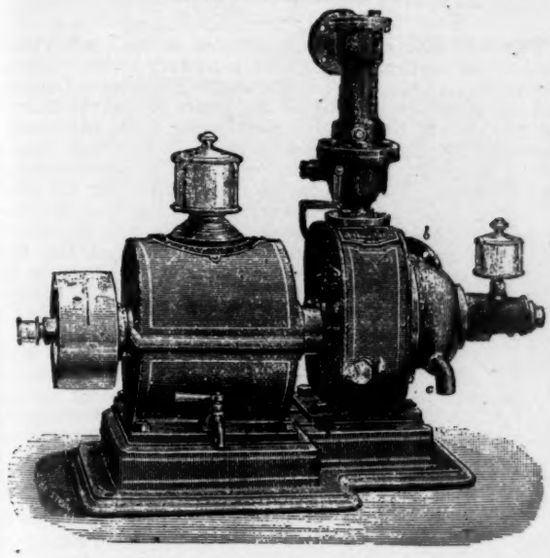


FIG. 28.—VIEW OF THE TURBINE MOTOR COMPLETE.

a three-wire system. Fig. 34 shows a complete electrical installation.

Turbine Pumps and Ventilators are further applications of

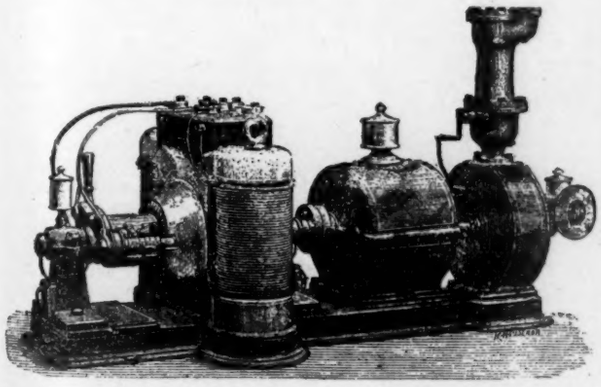


FIG. 29.—VIEW OF TURBINE COUPLED TO A DYNAMO.

the turbine. Fig. 35 shows a simple turbine pump. Fig. 36 is a compound turbine pump. Each of the two driving-shafts of the turbine are coupled to a centrifugal pump. They are

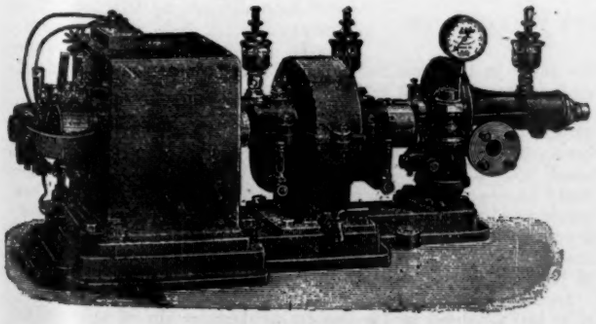


FIG. 30.—A DYNAMO TURBINE.

connected together in parallel to double the output, or in series to increase the pressure of the liquid as it is delivered.

ADVANTAGES OF THE LAVAL TURBINE.

1. In all rotating machines working at high speeds the wear of the parts subjected to frictional contact soon produces a play between these parts. Tightness being an absolute condition of economy for all of these machines, and as this tight-

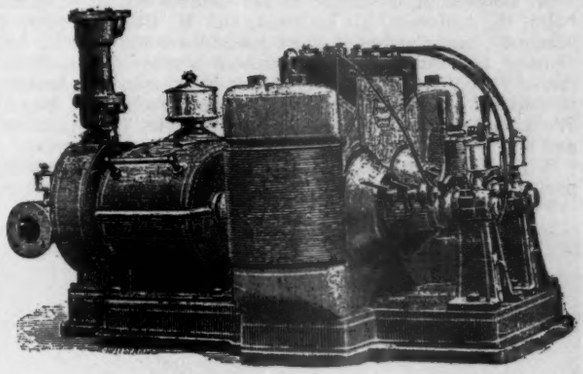


FIG 31.—A DYNAMO TURBINE WITH TWO SHAFTS.

ness soon disappears, the consumption of steam which, at the start, sometimes remains below 60 or 70 lbs. per H.P., soon rises to enormous proportions.

In the Laval turbines, on the other hand, the *vis viva* of the steam being the active agent, and not its pressure, there is always a play of .1 in. left between the wheel and the casing, so that no part is subjected to any frictional contact, and the consumption of steam remains practically constant, however long a time the apparatus may have been at work.

2. In principle the steam is of the same pressure upon both sides of the wheel. It therefore quite naturally follows the path which the passages through the wings offer to it, if these latter have the proper contour, and the direct passage to the exhaust is evidently *nil* as well at the time of the delivery of the machine as after it has been running for a time.

This claim has been substantiated in practice. In fact, it is sufficient to open one of the drips in the motor casing on the exhaust side to show that the steam has no velocity when it leaves, and that is the reason why, as we have just said, the inventor leaves a very perceptible play between the wheel and the casing, in order to do away with all frictional resistances upon the periphery of the wheel.

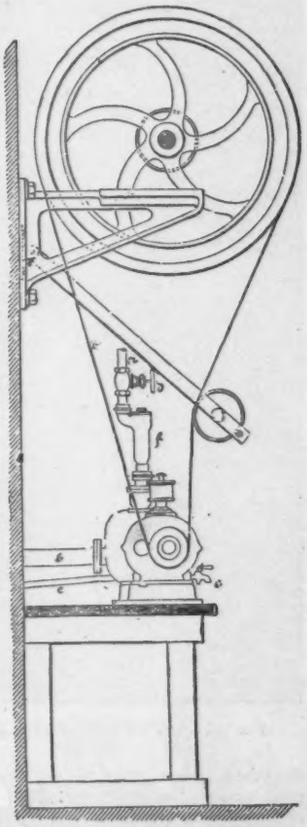


FIG. 32.—*a*, ADMISSION; *b*, EXHAUST; *c*, DRIP FOR WATER OF CONDENSATION; *d*, THROTTLE-VALVE; *e*, COCK FOR OIL DRIP; *f*, SEPARATOR-BOX.

3. Condensation in the machine can be neglected, whatever may be the pressure of the steam that is used. In fact, the steam is brought by its passage through the conduits down to exhaust pressure at the moment when it comes in contact with the wheel. High-pressure steam, and consequently steam at a high pressure, never comes in contact with the wheel, which does not, therefore, have to be subjected, like the cylinders of a piston engine, to those alternating high and low temperatures which are the main cause of condensation. The conduits can, furthermore, be entirely protected from the cooling action of the air, and this is the case with the Laval turbine where the conduits are absolutely protected by considerable thicknesses of metal.

4. The utilization of the steam is pushed to the last available limit, since in passing through the conduits it drops from the pressure existing in the boiler to that of the atmosphere. The result is that this machine shows an economy of consumption equal to that of the best steam-engines.

M. Coderblom, Professor at the Central School of Stockholm, M. Anderson, his assistant, and M. Uhr, Inspector of Measures, made a test of these machines while running condensing, and found that they showed a consumption of 19.8 lbs. of steam per effective H.P. per hour, with an admission pressure of 52 lbs. per square inch, and a vacuum of 26.4 in. We have had occasion to repeat these same tests several times, and have thus checked off the accuracy of these figures.

5. The Laval turbine consists practically of a single moving part, which is formed of a wheel turning freely in a steam-chamber and a train of gearing. There are no piston, connecting-rod, boxes at each end of connecting-rod, no valves or eccentrics, as we have seen from the engravings.

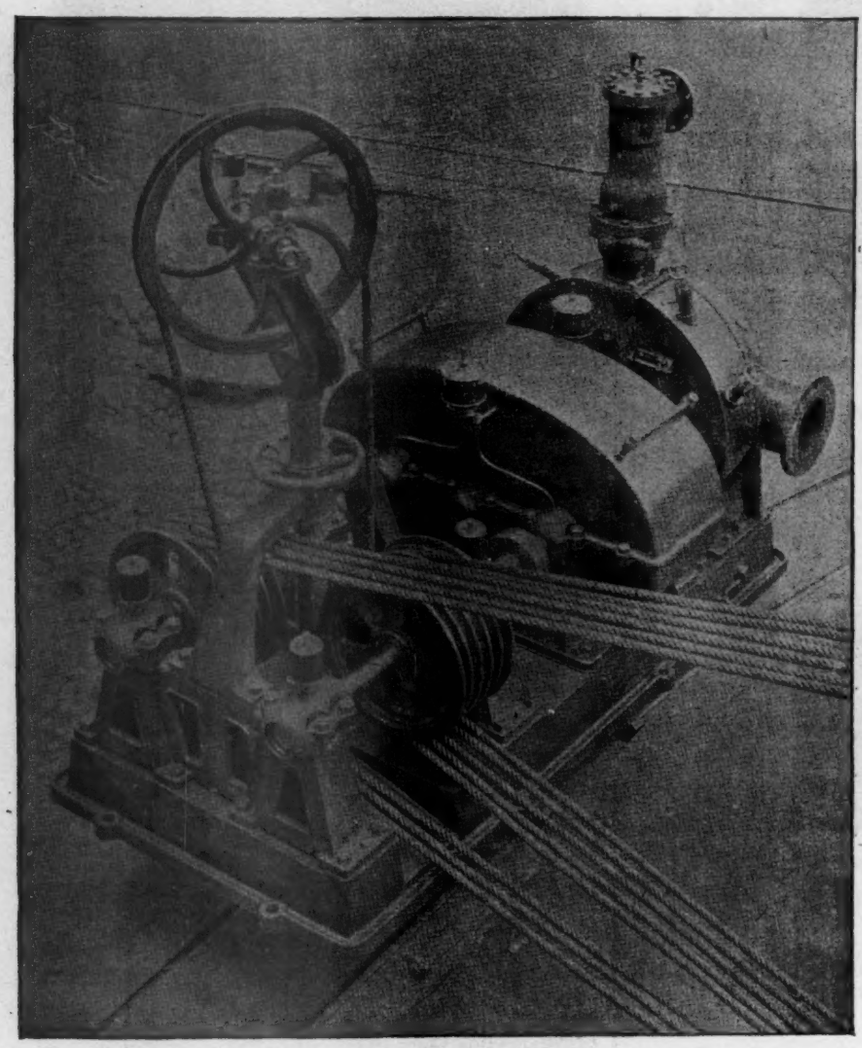


FIG. 33.—A TURBINE WITH TWO GROOVED PULLEYS FOR ROPE TRANSMISSION.

Finally, there are numerous advantages connected with the Laval turbine: great simplicity of construction; low passive resistances; no foundations; greatly reduced number of attachments; light weight; very uniform speed; low steam consumption; reduced cost for oil and packing; no constant attention required; easily taken down and inspected; silent running, and freedom from vibrations.

Thus the weight of the turbine can be scheduled:

For	5	H.P.	it weighs	only	286	lbs.,	or 57.2	lbs.	per H.P.
"	10	"	"	"	440	"	" 44.0	"	" "
"	15	"	"	"	517	"	" 34.46	"	" "
"	30	"	"	"	902	"	" 30.06	"	" "

All of these advantages have, furthermore, been established by a service of three years; about 6,000 H.P. had been put in service on January 1, 1895, in France and abroad, and everywhere their operation has left nothing to be desired.

CO-OPERATION.

Two movements which are reported in the London papers seem to be worthy of more than a passing notice. One was the meeting of the first International Co-operative Congress, and the other the opening of the ninth annual exhibition of the products of co-operative workshops. This exhibition is promoted by the Labor Association, a body which seeks to extend co-operative production based on the co-partnership of the workers. The success of co-operation for the distribution of commodities in Great Britain through the co-operative stores has been so great, that there is no longer any doubt as to the possibility or practicability of conducting business on a large scale on that system.

According to a statement issued by the Labor Association, the co-operative movement so far has been chiefly successful in storekeeping. "A marvellous plant has grown from the seed planted by the Rochdale Pioneers Society, when in 1844 they opened a co-operative store for the sale of goods to members on the basis of dividing the profits among the customers in proportion to their purchases. In Rochdale the co-operative method has so far supplanted private trade that there are now in the town three co-operative stores. In 1894 the societies had 18,785 members, holding a share and loan capital of £457,871, doing an annual trade of £391,080, at a profit for the year of £53,303." Spreading beyond Rochdale, up and down the country, the store movement has grown to very large proportions.

In opening a discussion of this subject the chairman, Mr. Frank Hardem, of the International Committee of the Co-operative Union of Great Britain, said that "in the distributive stores movement members must be shareholders, or they could not reap all the advantages. The system was a marvel of organization. Among the industrial organizations that had found their origin in the nineteenth century none had been such a power for good as the co-operative stores, which were some of the strongest examples of thrift, industry, and self-help. The wonderful growth of the movement was shown by the fact that the number of societies was now 1,674, with a membership of 1,343,518, a share and loan capital of £18,500,000, a reserve fund of £826,872, and an invested capital of £7,780,000, while the sales in 1894 realized £50,000,000, and secured a profit of no less than £5,000,000."

The success of co-operation for production has not been so great—in fact, to a very considerable extent its history has been one of failure and not of success. When, therefore, a small body of men who still maintain their faith in the possibility of co-operative production, and undertake to show what measure of success they have met with, their report is at least a very interesting one to all who hope for an improvement in the relations of employers and employed, and in the condition of both.

In a statement issued by the Labor Association, co-partnership is explained to be the equal partnership of labor with capital, "the system under which, in the first place, a substantial and known share of the profit of a business belongs to the workers in it, not by right of any shares they may hold, or any other title, but simply by the right of the labor they have contributed to make the profit; and, in the second place,

every worker is at liberty to invest his profit or any other savings in shares of the society or company, and so become a member entitled to vote on the affairs of the body which employs him."

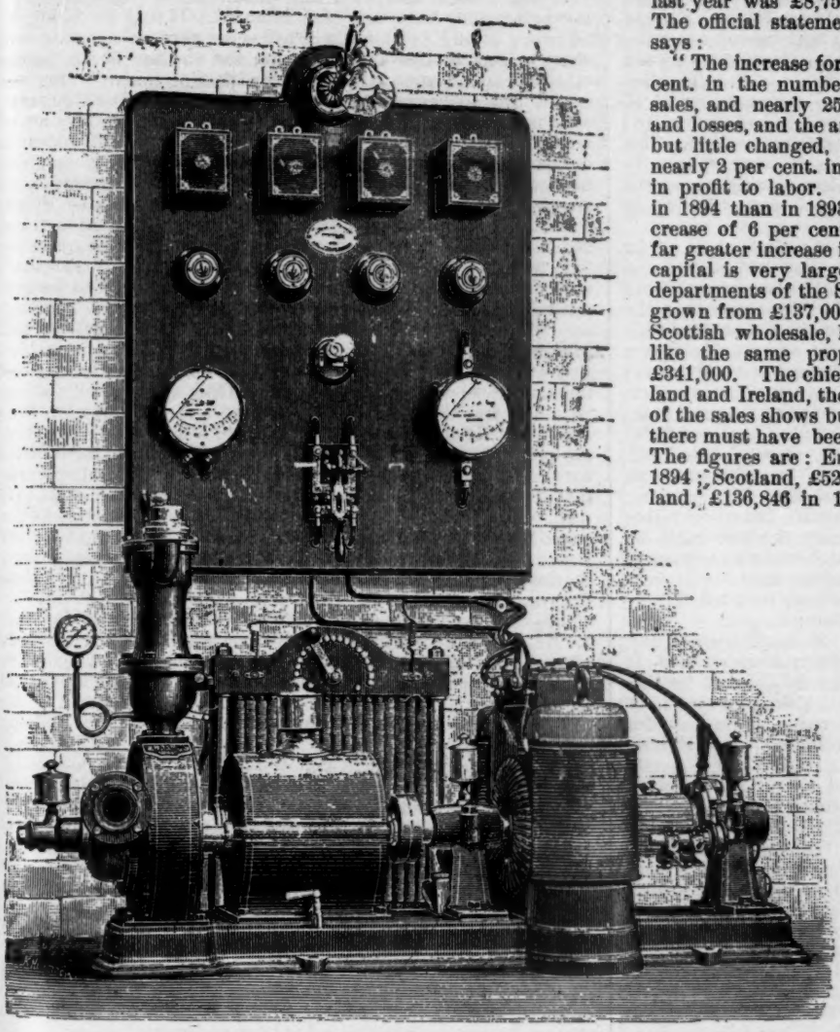


FIG. 34.—VIEW OF A COMPLETE ELECTRICAL INSTALLATION.

This system is carried out by the societies which exhibited the products at the Crystal Palace, and by the other societies in affiliation with the Association, numbering in all 120. Some idea of the growth of the movement may be gathered from

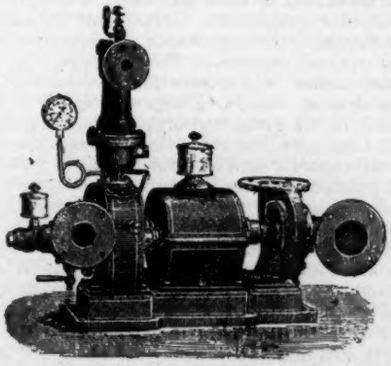


FIG. 35.—TURBINE AND PUMP.

the results of the working of these societies during last year. The number of societies has grown from 15 in 1883 to 109 in 1893 and 120 in 1894. Last year the sales amounted to £1,371,424, against £1,292,550 in 1893 and £160,751 in 1883. The capital (share, reserve, and loan), which was £103,436 in 1883, had grown to £639,884 in 1893 and £799,460 last year. As to profits, these amounted to £68,987 in 1894, to £67,663 in 1893, and £9,031 in 1883; the losses were £3,135 in 1894, £2,984 in 1893, and £114 in 1883, leaving the net profit £65,852, against £64,679 in 1893, and £8,917 in 1883. The "profit to labor" last year was £8,751 against £8,283 in the previous year. The official statement from which these figures are taken says:

"The increase for the year, it will be noticed, is 10 per cent. in the number of societies, 6 per cent. in value of sales, and nearly 25 per cent. in capital; while in profits and losses, and the amount of profit to labor, the figures are but little changed, there being, however, an increase of nearly 2 per cent. in net profits, and of about 5¼ per cent. in profit to labor. Seeing how much lower prices were in 1894 than in 1893, there can be no doubt that the increase of 6 per cent. in the value of goods sold covers a far greater increase in their volume. The great increase in capital is very largely accounted for by the productive departments of the Scottish wholesale, where the item has grown from £137,000 to nearly £249,000. The sales of the Scottish wholesale, however, have not grown in anything like the same proportion, but only from £295,000 to £341,000. The chief increases in sales have been in Scotland and Ireland, though even in England, where the value of the sales shows but a very small increase for the year, there must have been a considerable increase in volume. The figures are: England, £633,034 in 1893, £634,482 in 1894; Scotland, £522,670 in 1893, £583,118 in 1894; Ireland, £136,846 in 1893, £153,824 in 1894. In England, too, the profits are slightly less than in 1893, and the losses slightly more; while in Scotland and Ireland the profits are increased, and, as in 1893, no one of the Scottish societies shows a loss upon the year. Of the total losses shown—viz., £3,135—one society is responsible for £2,141. No losses are shown for Ireland, but the figures for that country are evidently incomplete. As to the expression, "profit to labor," only that part of the profit is meant which is allotted to the workers individually as dividend on wages. But it is the workers collectively who get the benefit of provident, educational, and special service funds, to which large shares of the profit usually go. Further, the workers get a large part of the profit assigned to committeemen, and the interest and profit to shares also go largely to them—often in respect of capitalized dividends on their wages. Finally, wages are often substantially higher than they would get elsewhere, and employment is more continuous. It would, therefore, be safe to take about double the £8,751 shown above as the real "profit to labor"—the money profit

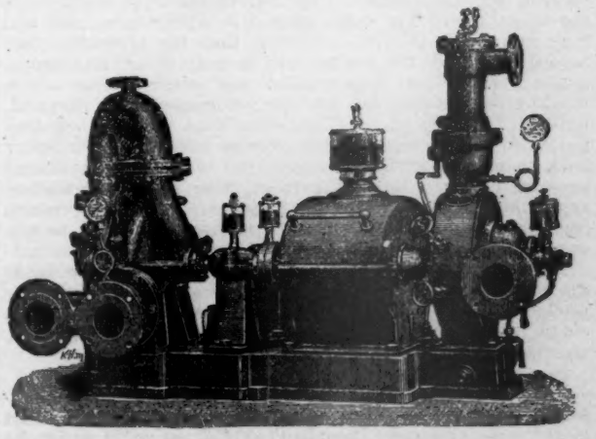


FIG. 36.—TURBINE AND COMPOUND PUMP.

we mean, apart from all other advantages. Four English societies—the Bramley Boot, Atherston Hat, Bolton Common-

wealth, and Walsall Bridle Bit—and one Irish—the Castlemahon Creamery—have failed during the year. They represented a trade of £9,779 only. Another society, whose trade in 1893 was £23,000, has been reconstructed, after compounding with its creditors; and one very small society, the Walsall Cart Gear, has been amalgamated with the Padlock Society of the same town. Upon the whole we may consider that the societies have stood the strain of one of the worst years known to British trade in this generation remarkably well. The fact that they have shown substantial growth—taken at least at 10 per cent.—even in such a year is good proof of their vitality; and the indications point to excellent progress in 1895. The above figures only apply to co-partnership in what are usually reckoned as co-operative bodies. There is another large growth of the movement—namely, the adoption of co-partnership in large capitalistic establishments."

In opening the exhibition Mr. Channing, M.P., said: "In the matter of co-operative production they had passed the initial stage and had taken a firm stand upon ground from which they could not be pushed back. This was that the producer should have a reasonable share in the profits of his work, and that he should have as direct and as adequate a share as could be given him in the management and control of the industry with which he was connected. The adoption of such a principle secured the most honest and the most practically useful labor in the world. According to the official reports of the Board of Trade, the weekly wages lost in 1892, owing to strikes and lock-outs, amounted in eight weeks to about £3,880,000, and in 1893 to £6,400,000. If, therefore, the capital of £800,000 was enough to enable 120 co-operative productive societies to work with success, the two sums he had mentioned would enable 12,000 of such societies to work."

During the opening session of the Congress Earl Grey occupied the chair, and in his presidential address took the following somewhat roseate view of co-operation:

"Wherever profit-sharing had been at work successfully for some years the most satisfactory results were visible. It acted as a great lubricant, reducing the liability of friction between individuals and departments; it induced a system of mutual foremanship, and consequently reduced the need for supervision; it encouraged fertility of resource in overcoming difficulties, devised cheaper methods of production, established a pleasant feeling of brotherhood among all connected with the work, and tended to remove that poisonous antagonism between employer and employed which constituted at the present time the greatest danger with which civilized society was threatened. (Cheers.) For in every corner of the civilized world, wherever labor had only a fixed and limited interest in the product of the industry in which it was engaged, the same ugly phenomena were to be found, in varying degrees, in the rival camps of employers and employed—secrecy, suspicion, angry jealousy, and growling discontent. It did not require a Solomon to tell them that when there was such an antagonism the result would be loss. By the desire of discontented workmen to do as little as possible in return for their wages and the desire of the employers to give as little as possible for the work they obtained two great evils were produced. The national output, on which the prosperity of society depended, was diminished, and the standard of character, on which the greatness of the State still more depended, was deteriorated. He had watched for many years the operation of the wage system in agriculture, and had long ago come to the conclusion that the present system tended to degrade the worker into an unthinking, mechanical automaton. What they wanted was some system which would raise that dull and soulless automaton into a cheerful, hopeful, thinking man. Experience went to show them that the only way to vitalize those human automata of industry back to manhood was to convert the hireling, with limited personal interests, into the partner, with wide and enlarged sympathies, and anxious, by reason of the interest which came from his partnership in the industry in which he was engaged, to make it a success." (Cheers.)

Later on, however, he admitted that the only difficulty in the way of applying the principle "was the want of any profits to divide." This is fundamental and serious, and is characteristic of all business enterprises, public, corporate, and individual.

In commenting on his remarks, the London *Times* says:

"Earl Grey adopted a tone not uncommon on similar occasions. He was enthusiastic, but full of a pained surprise that more people and more organizations did not enlist under the co-operative banner. That, indeed, is just what puzzles the ordinary onlooker. The figures quoted by Lord Grey are the usual figures—so many millions of turnover, so much profit to divide, the millions and the percentage being pretty much what they have been for a long time past. Looking to other nations, this congress being specially and emphatically international, Lord Grey of course quoted France; but it is a little disappointing, at this time of day, that he has no other instances to quote than those of Godin and Leclaire. These are very old friends, and what the outside world wants to know is whether they have not been imitated. If they have not, it affords a strong presumption that some personal reasons are there to account for their success; for nothing is more certain than that a successful commercial experiment, if its success is due to causes that are the same for everybody, very soon finds people to copy it. Lord Grey spoke up very zealously in favor of profit-sharing, appearing to identify it with co operation, from which it is really distinct; but, as he well knows, there are many grave difficulties behind. It may be a simple matter for an employer and his men to agree upon some kind of profit-sharing; but the pinch comes as soon as the men claim a voice in the management. Again, the case is seen to be not so simple as Lord Grey would wish to represent it when we read his rather naïve remark that capitalists would put their businesses on a profit-sharing basis 'as soon as the conditions of trade were favorable to the application of the profit-sharing principle.' Those conditions are favorable just when they are favorable to raising wages; and the trade-unions, for whose countenance Lord Grey appeals with some asperity, frankly prefer high wages. The chairman of the congress tells them that by refusing to admit the profit-sharing principle they are retarding the emancipation of labor, and we are inclined to agree with him. But he is surely aware that the trade-unions do not admit that emancipation lies that way. The question is fundamental; the co-operators and the profit-sharers answer it one way and the trade-unions another. It is, however, very desirable that in certain industries profit-sharing should be more widely tried, and especially, as Lord Grey said, in agriculture. But here again comes in that difficulty—the want, too often felt just now, of any profits to divide. It is quite an open question whether a laborer, if offered a choice between ten shillings a week with a share of profits and twelve shillings with no share, would not choose the latter."

In confirmation of the opinions of the *Times*, M. D. Andremont, of Belgium, said he was obliged to report unfavorably of the experiments made in that country on behalf of co-operative production. The main cause of failure was that the workmen were wanting in the necessary recognition of the difference of capacity which made it necessary that the manager of a co-operative productive institution should exercise adequate authority.

The Rev. Dr. Lorimer, of Boston, U. S. A., held that, when they had discovered the secret of real co-operation between all classes, then they would have entered upon a period of universal peace and happiness and prosperity.

Probably most readers will be disposed to agree both with the London *Times* and the American reverend doctor, provided there is a secret of co-operation which is doubtful. In this, as in so many other cases, it is a condition and not a theory which confronts us. Still productive co-operation does not seem hopeless. Co-operation for distribution is probably as difficult to accomplish in this and many other countries as co-operative production is in Great Britain. Co-operative stores have thus far invariably failed here, not because the theory of them is not correct, but because the condition of the people who should be most interested in them is not up to the co-operative requirements. Impatience of restraint and authority, insubordination, ignorance are insurmountable obstacles in the way of success in this direction. In all the so-called "communities" which have been economically successful, such as that at Oneida, Economy, near Pittsburg, the Mormons, and in all great corporations and trusts, like the Standard Oil Company, the republican or democratic doctrine of equality of capacity and control is totally ignored. Mr. Andremont pointed out the difficulty very clearly when he said that the workmen in Belgium were wanting in the necessary recognition of the difference of capacity which made it necessary that the manager of a co-operative productive institution should exercise adequate authority. What seems needed, not only in co-operative enterprises, but in all government, is some principle or system which will give authority to those who are fittest to control. Universal suffrage don't do that, never did, and never will. Co-operative production directed by the counting of noses will probably never succeed. Some sort of autocracy of intelligence and ethical capacity and not demotic government must have control.

Exhibition in South Africa.—A notice has been forwarded to us of an exhibition which is to be held in Cape Town, under the management of the American Exposition Company, and which will open on November 18, 1895, for a period of six weeks.

MALLEABLE CAST IRON.

In a paper that was read recently before the American Society of Civil Engineers, Mr. H. R. Stanford gives some interesting facts regarding the processes of making and the properties of malleable cast iron. At the outset he makes the remark, to which we will all agree, that if any systematic and scientific study has been made of malleable cast iron, the results have been very carefully kept private. He assigns as a reason for this neglect the fact that, until recently, only very unimportant shapes, as far as strength and uniformity were concerned, were made by the process, and specifications and inspections were not needed. The late extensive use of malleable cast iron in the Master Car-Builders' vertical plane coupler required the metal in a form in which it was subjected to very hard and uncertain usage, and where failure to withstand that usage might result in serious loss of life as well as property. The importance of quality in the castings led to the drop test being inserted in the Master Car Builders' specifications, and malleable cast iron was first subjected to test treatment.

Next to iron, the most important element in malleable cast iron is carbon. A high percentage of carbon is necessary for fluidity; and fluidity is of prime importance, not only that the percentage of lost moulds may be small, but that the iron may run clean and smooth, and the resulting work have a perfect surface. For strength and malleability the unannealed castings must have no graphitic carbon, but the total percentage must be in the combined state. With a given molten iron at a certain temperature, if the iron be poured into a mould of a certain section the casting will contain all of the carbon in the combined state, and the fracture of the annealed specimen will be of a uniform dark fibrous appearance. If the mould be of a smaller section, the casting made from the same iron will show the total percentage of carbon as combined carbon, but there will be a surface chill, which in the annealed specimen will show as a white skin. If the mould be of a greater section, then the rate of cooling of the iron will be so slow that a part of the carbon will have time to separate from the iron as graphitic carbon, and will show in the fractured unannealed casting as scattered spots of graphite about as large as the head of a small pin, the number of spots increasing with the section of the casting. The above three castings, if annealed, will show the following physical properties. The first will have an ultimate strength of from 42,000 to 46,000 lbs., and will stretch and reduce about 6 per cent., and may be considered a most desirable iron. The second will show in fracture a white crystalline skin, increasing in thickness as the section is lighter, with a black fibrous centre; the ultimate strength will be about 52,000 lbs., and the stretch and reduction about 3.5 per cent.; if the section is so light that the whole fracture is white, then the iron will be very malleable and tough. The third casting will be little better than gray iron, with a strength of from 25,000 to 35,000 lbs. depending upon the percentage of graphite in the unannealed iron, and with practically no stretch or reduction.

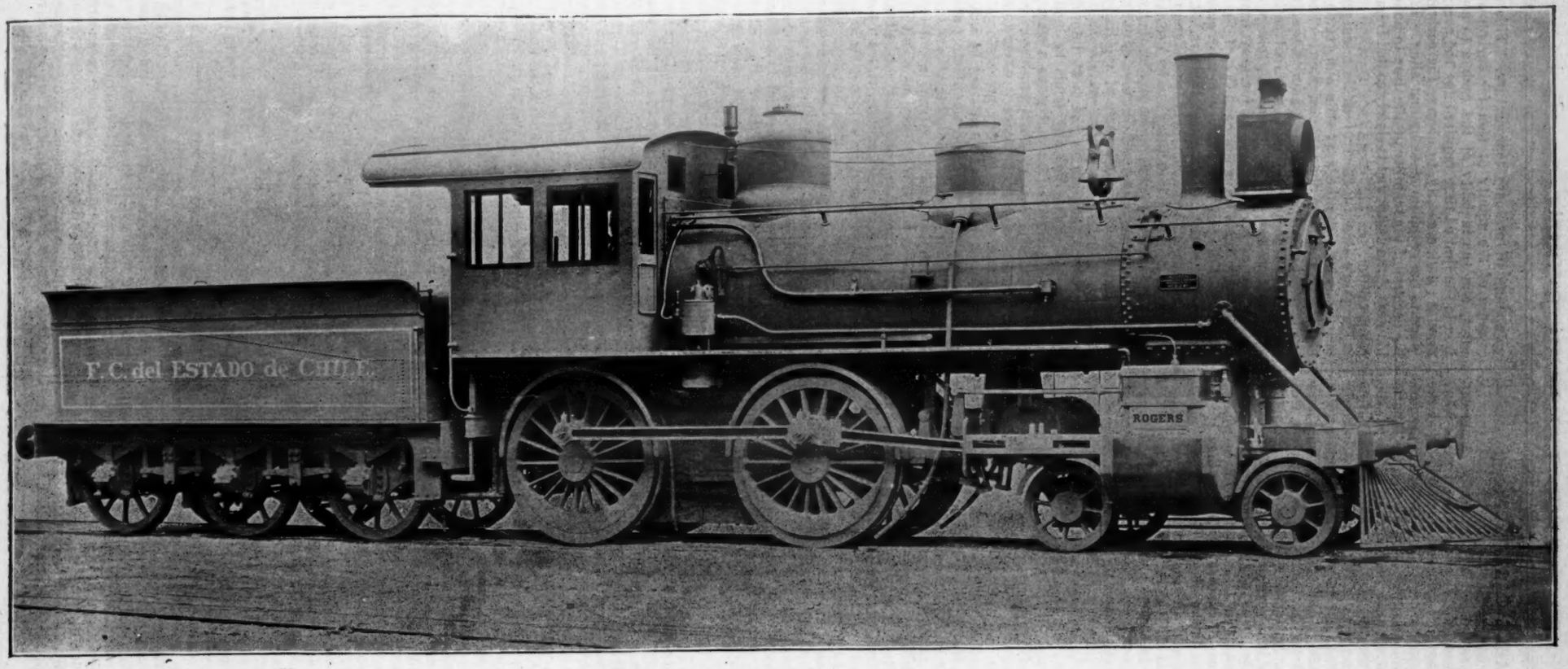
The chemical action in the furnace seems to be primarily the combining of the graphitic carbon of the charge with the iron, a combination made possible in the fused mass by the temperature; and secondarily a small burning out of carbon and slagging out of silicon and manganese. The secret of mixing is in using material containing combined and graphitic carbon in such proportions that at the temperature best adapted for pouring the graphitic carbon shall all have combined with the iron. To assist in preventing chilling in the mould, a limited amount of silicon is desirable. A chill is objectionable because in one piece there will be two different kinds of iron which have different physical properties and which do not act the same in service. Either kind of iron by itself would be stronger than in combination with the other. Chemical action involves atoms; therefore if all carbon exists in the combined state in the annealed iron, it must be distributed through the mass in infinitesimally small particles, and when these particles are liberated from the iron in the subsequent process of annealing, they must each be enclosed in an iron cell. Hence the definition might be given for malleable cast iron that it is essentially a mixture of metallic iron and graphitic carbon, the carbon being in finely divided or atomic particles and the iron being the matrix for these particles. Gray iron differs from malleable cast iron in that the carbon, instead of being in atomic particles, is in crystals, and these crystals cut the iron structure and make it discontinuous. In malleable cast iron the continuous cellular iron structure is responsible for the strength of the product, and its malleability and ductility are limited by the non-deformable particles of graphite which occupy the cells. The process of making malleable cast iron is then first to make the hard, brittle carbide of iron which is a stable compound of ordinary temperature. This step is possible because of the affinity of iron for carbon at high temperatures, and the inability of the carbon to separate from the iron in the limited time required for the compound to cool in moulds; and, secondly, to change the carbon from the combined to the graphitic state by annealing. This step is possible because of the inability of the iron to hold carbon in combination if the compound is slowly cooled from a high to a low temperature.

Shrinkage is a function of casting temperature, and the nearer the iron is to the gray state and yet shows no graphite in fracture, the less will be the shrinkage. The normal shrinkage of hard iron is very nearly $\frac{1}{4}$ in. to the foot, and there is an expansion of about $\frac{1}{8}$ in. to the foot as the effect of the annealing process, so that the net shrinkage is about $\frac{1}{8}$ in. to the foot, or about the same as for gray iron. Inasmuch as shrinkage depends upon the condition of the carbon, and the condition of the carbon depends upon the section of the moulds, and because abnormal shrinkage is so undesirable, the necessity arises for different mixtures for different patterns. The shrinkage of cupola iron prohibits its use for a great many shapes, because of the imperfect mixing that necessarily characterizes cupola melting, and because of the factor of safety required in the charge to be sure of avoiding gray iron in the castings.

After carbon, sulphur is the next important element in malleable cast iron. Sulphur tends to hold the carbon in combination with the iron and gives a stronger product because of the semi-steel which it produces. Sulphur is undesirable because of the hindrance it offers to annealing. The shapes ordinarily made by this process need not have great strength, but it is desirable that they be soft and capable of bending, and that the time of manufacture and cost be as low as possible. To show how sulphur affects the time necessary to anneal, couplers which analyzed about 0.040 per cent. in sulphur, and in which were sections about $1\frac{1}{2}$ in. thick, were thoroughly annealed in three and one-half days, while iron bands for buggy wheels, which were no more than $\frac{1}{4}$ in. thick and analyzed about 0.150 per cent. in sulphur, were invariably hard if given less than five days. If sulphur is carried as high as 0.200 per cent., enough carbon is retained in the combined state to give to fractures a uniform crystalline appearance, and the method is employed to make a so-called hard or special steel. This product in ordinary sections does not anneal in less than nine days. Special pains should be taken when buying coke for cupola melting to get a coke low in sulphur, as the iron coming in contact with the fuel picks up sulphur, and delay in the annealing process, with the accompanying wastes, is the result.

It is very unusual to machine any form made of malleable cast iron, as such treatment removes the strongest portion, the skin; and a tool, no matter how sharp, tends to drag the metal, and so leave small scratches or furrows, which offer starting places for breaking. An undressed cast form is necessarily irregular, and this irregularity, increased by the draft of the pattern, made the measurement of the original area and of the fractured area rather unsatisfactory work, and that the error might be partially eliminated, several bars of each kind were broken and the results averaged. With the idea that a cylinder can be cast more perfectly than a rectangle and that in a cylinder the shrinkage is not so damaging as in a rectangle, the form of the test bar was changed, and bars beginning with one 2 in. between shoulders and $\frac{1}{16}$ in. in diameter were used. In the first set of bars the unannealed sample was taken from the same bar, which was afterward drilled in the flat part for the annealed sample. For the cylindrical specimens, one of the unannealed bars was broken and the sample taken from the portion $\frac{1}{16}$ in. in diameter, and the annealed specimen was taken from near the fracture of one of the tested bars. In every case more weight should be given to elongation than to reduction of area, because of difficulties in determining the exact areas for computing the latter. With the exception of one case, the bars composing the sets were cast from the same ladleful of iron, drawn about the middle ladleful of the heat. All test bars received the same treatment in the annealing oven as far as position in the annealing pots and location in the oven were concerned.

The results obtained are not sufficiently numerous and uniform to warrant any general conclusions regarding the effect of manganese and phosphorus, further than to say that phosphorus seems to be a very passive element and anything but the bugbear which it is in steel. A limited period of anneal, judging from the results, might be considered as giving better results than an indefinitely longer one, both as regards strength and malleability. The fact that there was no sure way of telling whether bars were thoroughly annealed and yet not weakened by over anneal makes the physical results given a



TWO-CYLINDER COMPOUND LOCOMOTIVE.

BUILT BY THE ROGERS LOCOMOTIVE WORKS, PATERSON, N. J., FROM THE DESIGNS OF MR. REUBEN WELLS, SUPERINTENDENT.

little uncertain as representing an iron corresponding to the analyses accompanying the results, and only by averages of many tests can the truth be known.

In the tables that are appended to this paper the author has given some valuable and interesting information regarding the strength and other physical properties of malleable cast iron. In a large number of samples made from charcoal pig iron it was found that the average tensile strength per square inch was 42,910 lbs., with a percentage of reduction of 3.81 and of elongation of 3.97. With samples taken from castings made from coke pig the tensile strength was 47,930 lbs. per square inch, and a percentage of reduction of 4.41 and of elongation of 5.81. If the author would supplement this work by a report on the observed limit of elasticity of malle able iron, he would add to the obligations that he has placed upon the engineering community, since that is really the point by which the practical utility of the metal is marked.

COMPOUND LOCOMOTIVE FOR THE STATE RAILWAYS OF CHILI.

THE accompanying engraving is from a photograph of a compound locomotive recently completed at the Rogers Locomotive Works, from designs by Mr. Reuben Wells, the Superintendent of those works. The gauge of the Chilian roads is 5 ft. 6 in., and the fuel which will be used is bituminous coal. The weights and general dimensions are as follows:

Total weight	117,000 lbs.
On driving-wheels	72,000 lbs.
" truck-wheels	45,000 lbs.
Wheel base, total	22 ft. 1' in.
Wheel base of driving-wheels	8 ft. 3 in.
Diameter of "	5 ft. 6 in.
" " truck-wheels	2 ft. 9 in.
Size of journals, driving-axles	8 in. × 10 in.
" " " truck-axles	5½ in. × 12 in.
Diameter of high-pressure cylinder	19 in.
" " low " "	28½ in.
Stroke of piston	24 in.
Diameter of piston-rods	3½ in.
Steam ports, H.P. cylinder	22 in. × 1⅝ in.
" " L.P. "	29 in × 1⅝ in.
Exhaust " H.P. "	22 in. × 3¼ in.
" " L.P. "	29 in. × 3¼ in.
Width of bridge	1¾ in.
Slide valves	Richardson's balanced.
Steam pressure	190 lbs.
Boiler material	Steel.
" " thickness	⅜ in. and ⅝ in.
Outside diameter of barrel of boiler at first course.	58 in.
Horizontal seams	Butt sextuple-riveted.
Circumferential seams	Double-riveted lap.
Crown sheet stayed with crown bars.	
Diameter of dome	30 in.
Number of tubes	208
Diameter of tubes outside	2 in.
Length of tubes over tube plates	11 ft.
Material of tubes	Brass.
Length of fire-box	5 ft.
Width " "	3 ft. 6 in.
Depth " " front	87½ in.
" " " back	86½ in.
Material of fire-box	Copper.
Thickness of fire-box plates	½ in.
Brick arch in fire-box supported on studs.	
Cast-iron grate with stationary bars.	
Boiler is fed by Monitor injectors.	
Capacity of tender, water	3,000 galls.
" " " coal	6 tons.
Tender frame made of ⅜ in. steel slabs.	
Diameter of tender wheels	48½ in.
Material " " "	Wrought iron with steel tires.
" " " axles	Hammered iron.
Journals " " "	5 in. × 8 in.

The engine is equipped with Westinghouse 9½-in. brake-pump, the brakes being applied to the tender-wheels. The cab is made of steel, as shown by the photograph. The roof and inside of cab is lined with wood.

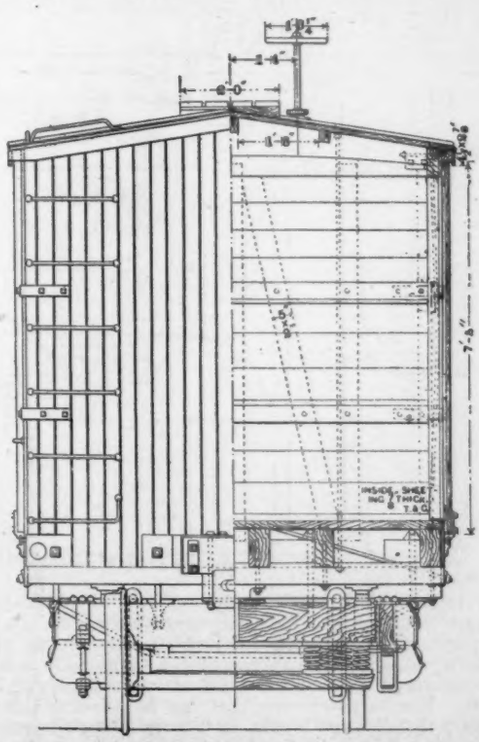
The tender, it will be seen, is of the European type, with six wheels and slab-frames. This design was supplied by the authorities of the road for which the engines are built. It may be said that this design is being regarded with more favor by American engineers of late years than it was when the generation of master mechanics who preceded the present one were in control of our railroad engineering.

It would be impossible to explain the construction of the compound features of this engine fully without elaborate engravings, which we expect to give in a future number. It may be said, though, in a general way, that steam is conducted to the high-pressure cylinder by a pipe in the back part of the smoke-box. The general form of this pipe is that of an inverted letter ↄ. The exhaust passage of the high-pressure cylinder is connected with the steam-chest of the low-pressure cylinder by a pipe of large diameter of the form of an inverted letter ∩, which also acts as a receiver. This is connected with the high-pressure steam-pipe by another 2-in. pipe, which has a reducing-valve between the receiver and the supply of high-pressure steam. This reducing-valve is arranged so that it can only open when the reverse lever is thrown forward or backward to its extreme limit, and is controlled by the mechanism shown on the side of the boiler in the engraving. Before starting, when the reverse lever is in its forward position, if the throttle-valve is opened, the inflowing steam into the high-pressure steam-pipe opens the reducing-valve, which permits live steam from the boiler to flow into the receiver-pipe, and at the same time closes an intercepting-valve in the receiver-pipe, between the high and low-pressure cylinders, which prevents the live steam which passes through the reducing-valve from entering to the exhaust side of the high-pressure piston. This reducing-valve is so proportioned that it closes when the pressure in the receiver-pipe reaches about 56 per cent of the boiler pressure, and opens when it falls below that. Consequently as soon as the throttle-valve is opened, and before the engine starts, the receiver-pipe is filled with live steam of a reduced boiler pressure, and as soon as the high-pressure cylinder exhausts into the receiver-pipe and increases the pressure, so that it is over 56 per cent. of the boiler pressure, it opens the intercepting-valve, so that steam can flow directly from the exhaust side of the high-pressure cylinder to the steam-chest of the low-pressure cylinder, and simultaneously closes the reducing-valve, so that no more live steam from the boiler can pass directly to the low-pressure cylinder. After the engine has been started and the reverse lever has been pulled back, the reducing-valve is closed and held in that position by the action of the mechanism shown in the engraving.

A number of compound engines of this type have been built by the Rogers Company, and the best evidence of their success is the receipt of duplicate orders.

STANDARD BOX CAR OF 60,000 LBS. CAPACITY —GRAND TRUNK RAILWAY.

THE Grand Trunk Railway, a description of whose works at Montreal appears in another column of this issue, has adopted standards for the greater portion of the output of their shops. Among others they have a standard box car, of

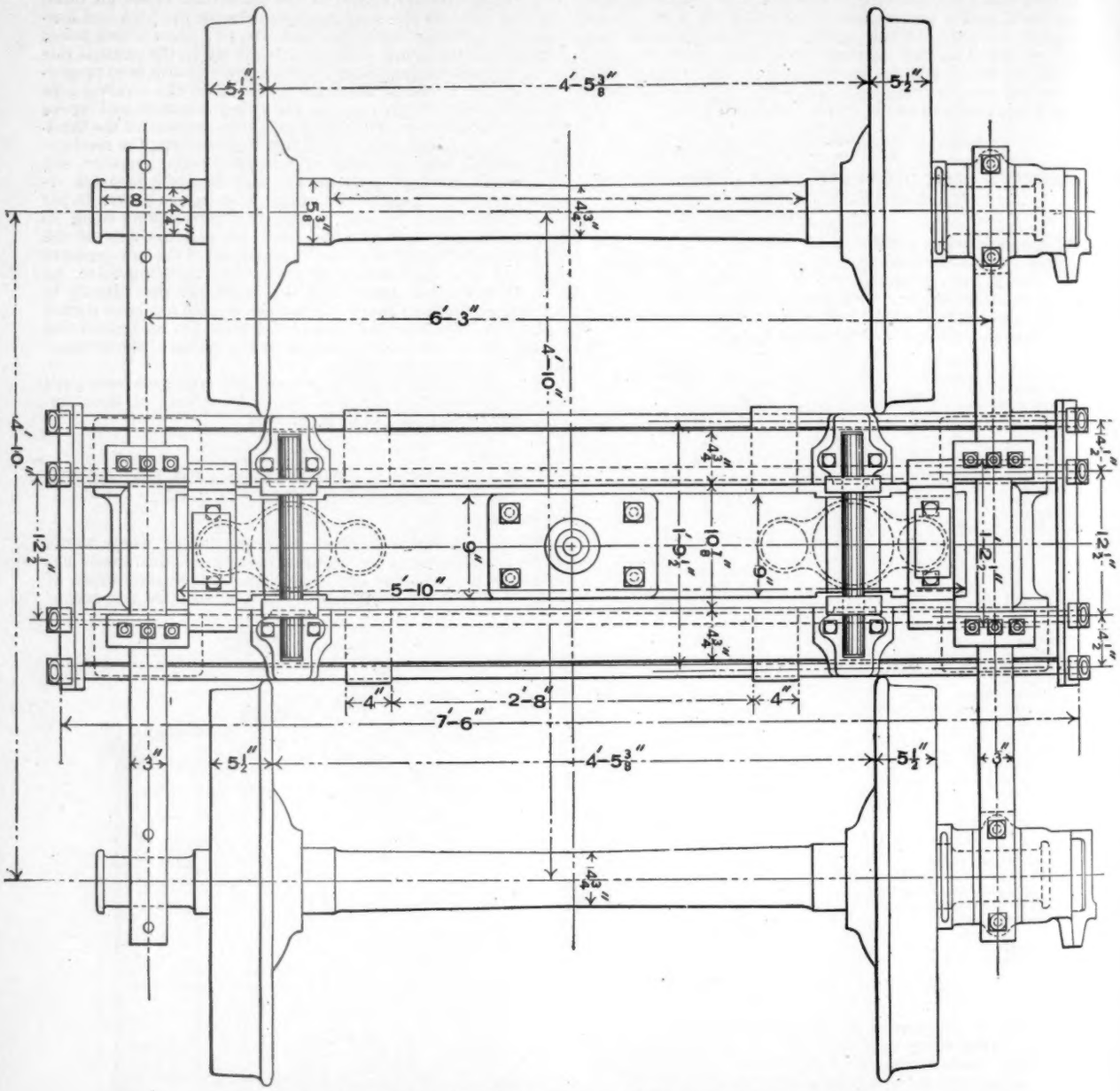


END ELEVATION OF STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

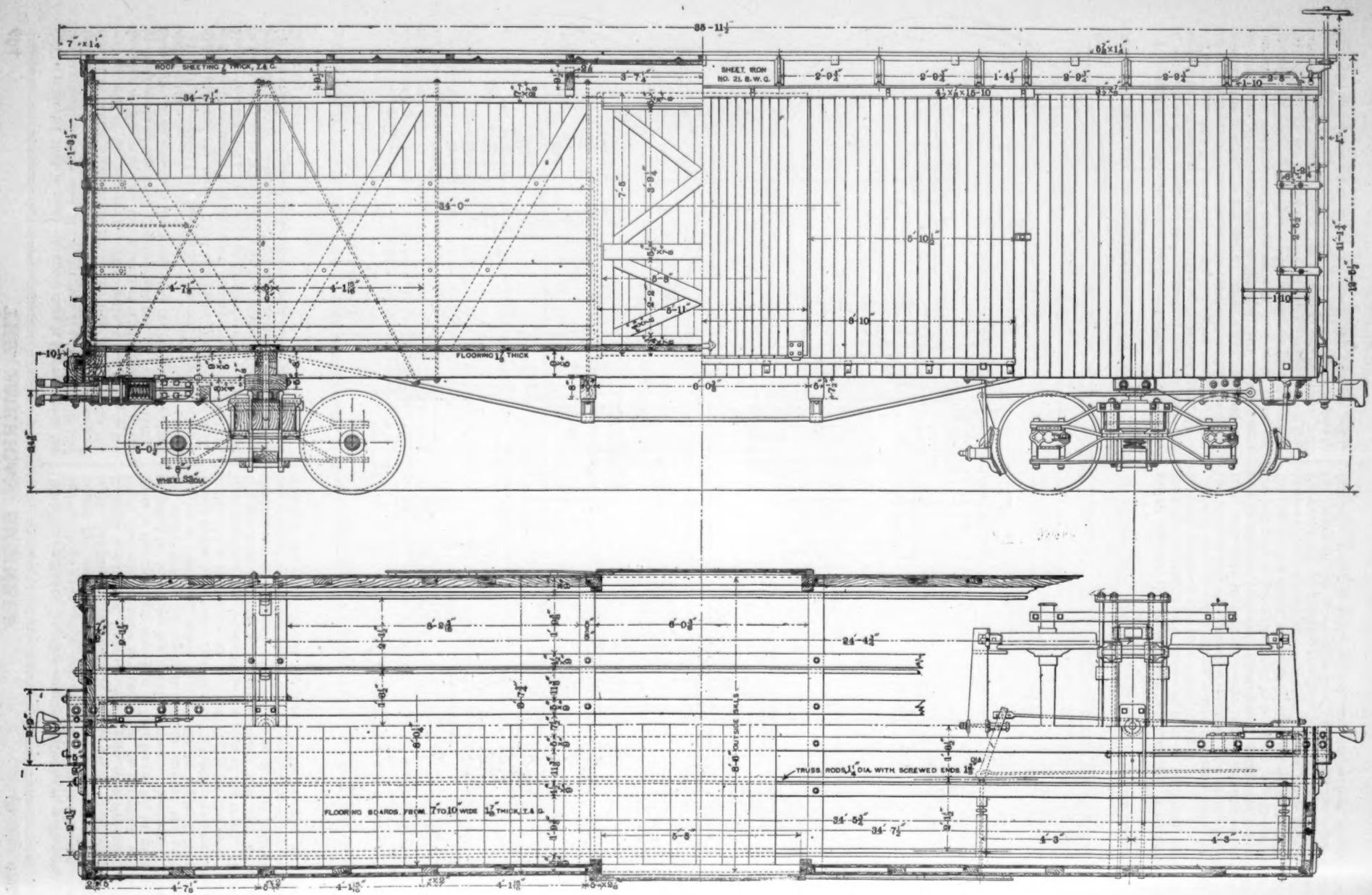
which we present engravings that are reproductions of working drawings. There are some peculiarities about these cars that are worthy of attention as being variations from the common practice, and yet are backed by very substantial reasons

for their existence. In the general outline of the framing there is little variation except in minor details. The counter-brace, for example, is heavier than that used in some places, and the truck centre is brought out nearer to the end of the car. The body bolster is of wood strongly trussed, and the main truss-rods for the body have no turnbuckle in the centre, where we usually find it. The reason given for this is that if the centre of the body sags at all, it must be raised by shortening the truss-rods, and that it makes no difference where those rods are shortened; that is, they may be taken up at the ends or in the middle, indifferently. Also that the raising of the body is not done by simply screwing up the rods, but they are first relieved of all strain by jacking. By the use of the continuous rod, also, the expense of the turnbuckle is saved, and the danger of its slackening off and thus becoming loose obviated. The only objection that can be raised to this construction is that if a rod breaks, it is more difficult to put in a new one where there is no turnbuckle than where one is used; but, on the other hand, the breaking of truss-rods is such a rarity that the saving effected in the other direction is a practical insurance on this one possible source of loss.

As all parts of the car have been reduced to standard sizes, the work of construction is greatly simplified and cheapened. Whether new cars are being built or not, the various parts can be made in quantities, as they will surely be needed for repairs, and in this way the piecework system can be introduced with advantage. Wherever it has been found to be advisable to do so, special machines have been designed to do duplicate work in quantities, and in our next issue we will illustrate a checking machine that has been built in the shops to do the checking or gaining on the belt rails. An examination of the drawing will show that these belt rails have a width of 2¾ in., and that the body braces have a width of 2 in. It is therefore necessary that the belt rails should be checked or gained to a depth of 2 in. to allow for the passage of these braces and posts. There are five of these checks in the length of each rail, three of which stand at an angle. To do this on a machine where only one can be done at a time requires considerable time, to say nothing of that required either for the laying out of the work or the setting of the machine and the repeated handling of the parts. With the machine that is used for the purpose no laying out is required, and, after the machine has once been set, everything that comes from it is in exact duplicate and interchangeable. This is evidenced by the ease and rapidity with which the new work can be put together, and the closeness of the joints in the finished framing. The same system is employed in other parts of the cars, such as the body bolsters, the cross-tie timbers, etc.



PLAN OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

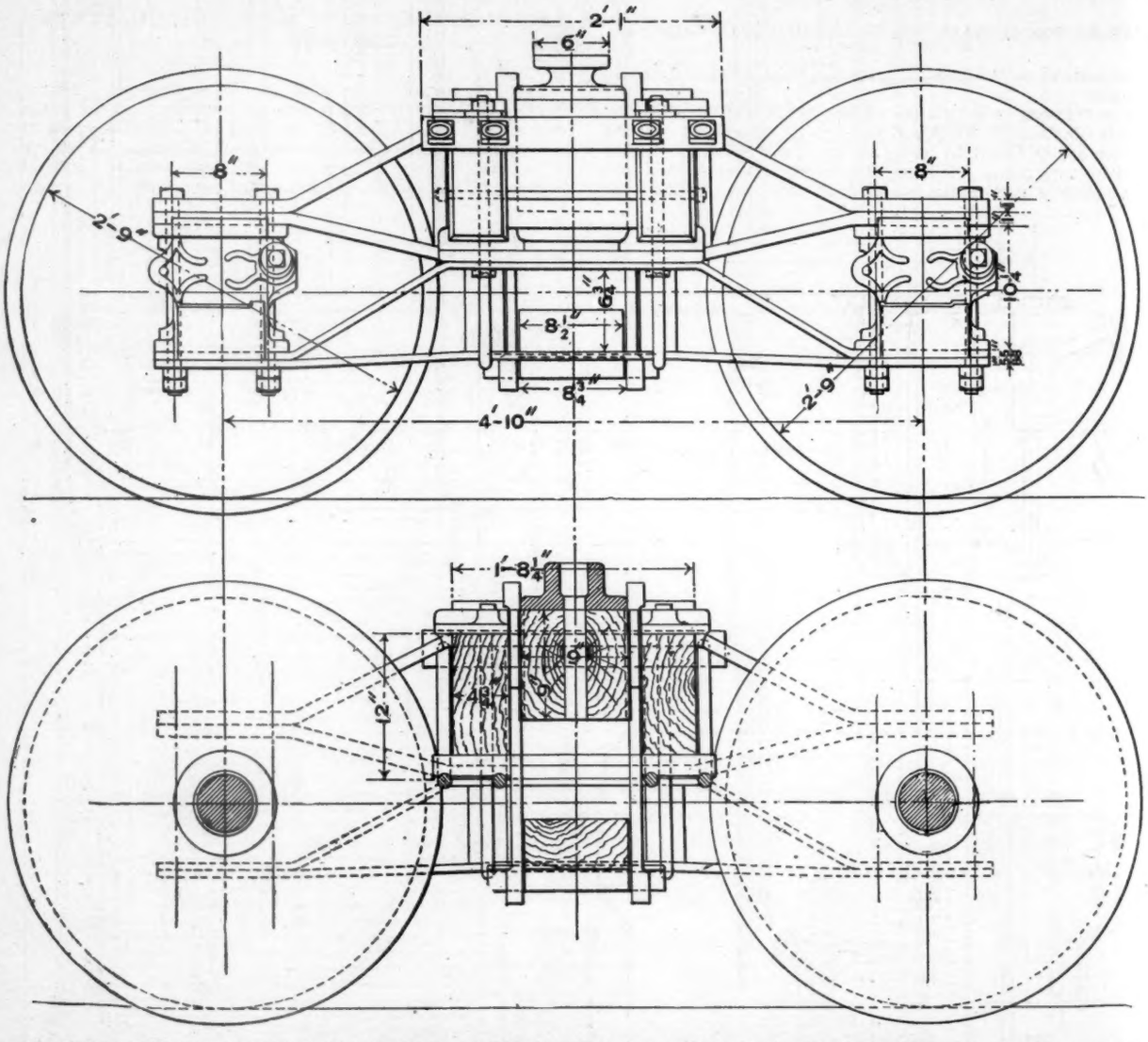

ROOF SHEETING ⅞ THICK, I & C.
SHEET IRON NO. 21, B.W.G.
FLOORING 1¼ THICK
WHEEL 33 DIA.
FLOORING BOARDS FROM 7 TO 10 WIDE 1¼ THICK, I & C.
TRUSS RODS 1¼ DIA. WITH SCREWED ENDS 1⅝ DIA
OUTSIDE SILLS

STANDARD 60,000 LBS. CAPACITY BOX CAR, GRAND TRUNK RAILWAY.

The material that is used on these cars is Georgia pine for the longitudinal sills and Michigan oak for the end sills and framing; the remainder of the car is for the most part made of Canadian white pine, while all of the iron used is from the rolling mill of the company. The castings are made in the foundry at Montreal, and the wheels cast at Hamilton. It is in every sense of the word a home-made car. The only things that come from abroad is the wood that is grown in Michigan and Georgia.

It will be noticed that the coupler shown in the drawing is of the link-and-pin type. This is still in use upon the road, but they have under consideration the adoption of one of the Master Car-Builder type, but have as yet come to no decision in the matter as to which one will be chosen. It is probable, however, that when one is adopted arrangements will be made for the erection of suitable foundries and facilities for manufacturing the same.

With the ordinary bar the column bolts have a diameter of $1\frac{1}{4}$ in., which calls for a hole at least $1\frac{5}{16}$ in. in diameter, and where the car-builder is not sure of the accuracy of his work this hole is increased to $1\frac{3}{8}$ in. With a $1\frac{5}{16}$-in. hole through a 4-in. bar there is left $2\frac{11}{16}$ in. of metal. On this truck the column bolts are only $\frac{7}{8}$ in. in diameter, and the holes in the arch bars are $1\frac{3}{16}$ in. This leaves $2\frac{5}{16}$ in. of metal, or just $\frac{1}{4}$ in. less than the usual practice. These small bolts are really not called upon to sustain any of the carrying strains of the truck, since this is done by a $\frac{7}{8}$-in. U bolt that passes beneath the lower arch bar, and is held up by a nut above a plate that lays over the top bar and takes the three bolts that come in a line, as shown in the plan of the truck. These U bolts hold the bars so firmly together that they seem to supplement the strength of the bars, so that no difficulty is experienced by the loss of the $\frac{1}{4}$ in. of metal due to the narrow width of the bars. So, as the proof of the pudding is in the eating thereof, the truck must be considered to be of ample strength, inasmuch as it shows no sign of weakness, and does its work in the service into which it is put.



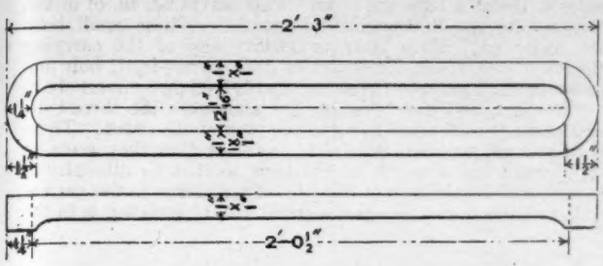
SIDE ELEVATION AND LONGITUDINAL SECTION OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

In regard to the dimensions of the car and of the parts forming it, they are so fully given on the engraving, that we refer our readers to that source for information upon this subject.

The truck that is used under the car varies, perhaps, from the common practice more than the car itself. The first thing to strike the observer is the use of outside-hung brakes, and the small size of the iron used in the arch bars. It has been customary to use iron that measures 4 in. × 1 in. or $1\frac{1}{4}$ in. for the top and intermediate bars, while here we find the width reduced to 3 in. for trucks that are to carry cars of 60,000 lbs. capacity. An examination of the construction, however, will show that the actual amount of metal left after the holes are drilled is about the same as where the wider bars are used.

There may be other places where the same thing is done, but if there are, we are not aware of it; for in the making of these arch bars they come to the car department at the same cost as that of ordinary rolled iron. As the bar comes from the last pass in the rolling mill it is cut to lengths and shaped for use in the truck while it is still hot, so that there is no extra expense attending the making of the truck frames with the exception of drilling the bolt-holes. It is merely one of the instances that go to show how thoroughly the work in the Montreal shops is systematized, and emphasizes the advan-

tages of having a standard and living in accordance therewith. It will be noticed that the oil-boxes are fitted with the Fletcher journal-box lid. This was adopted by the Grand Trunk Railway at the time the Fletcher lid was the standard of the Master Car Builders' Association, and when the standard



HANGER FOR 60,000 LBS. TRUCK, GRAND TRUNK RAILWAY.

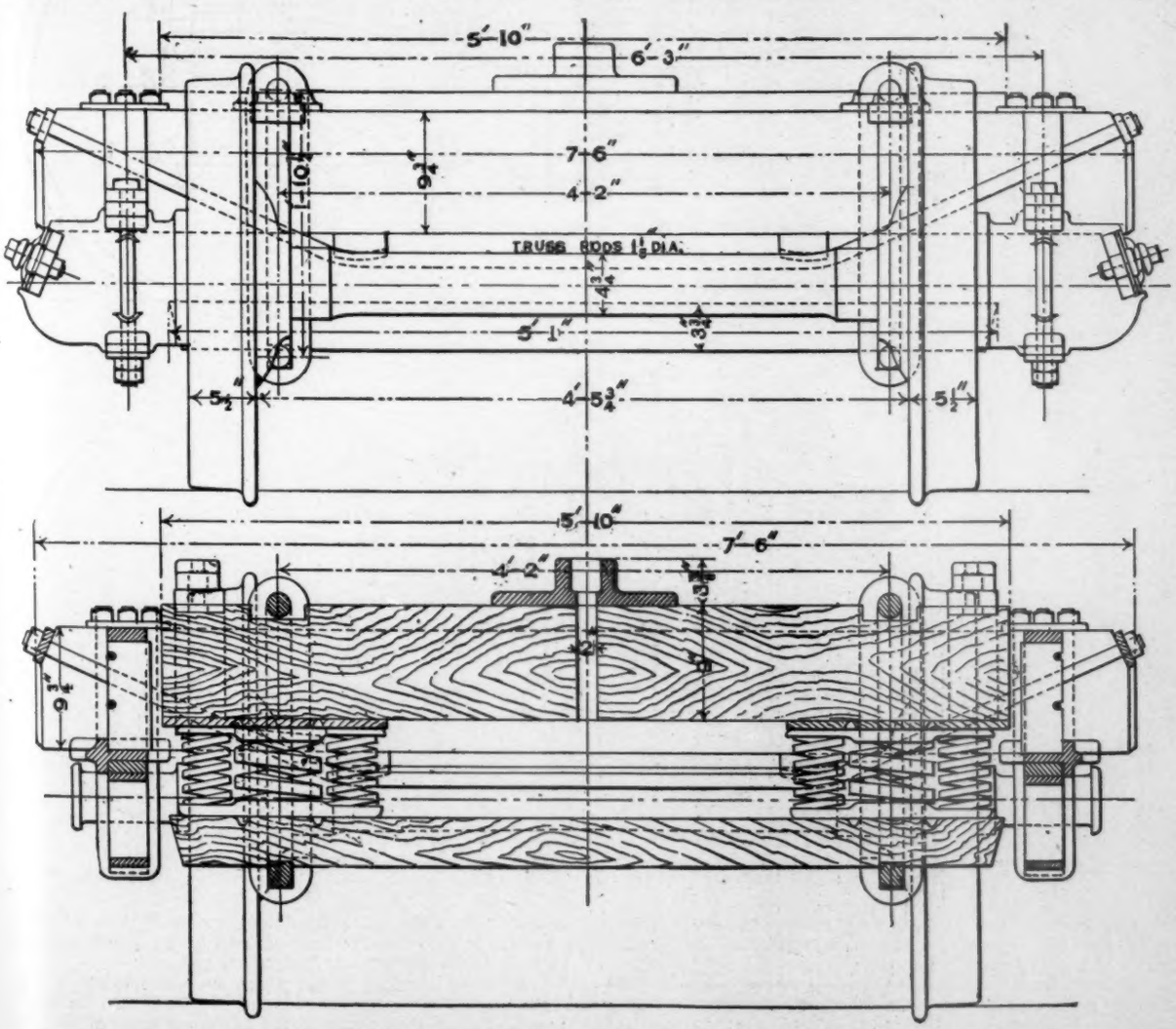
was changed to the present form the road continued its old practice.

The transoms and bolsters of this truck are made of oak that is obtained in Michigan, and it will be noticed that the former are stiffened by deep trusses, two 1¼-in. rods being used for each piece. This trussing is so deep and strong that it practically carries the whole load that is put upon the truck. The bolster has no trussing at all, and consists of a stick of oak 9 in. square. As the springs come below and inside of the side bearings, and the distance out from the centre is thus made very small, trussing has been found to be unnecessary. We give a small engraving showing the construction of the truck hangers, from which it will be seen that they are strengthened and enlarged at the bearing points. This gives a better wearing surface than where the metal is continued at a uniform thickness over these places.

Like the car body, the truck is of home-made material with the exception of the wood, and of course that is all worked on the same plan as that adopted for the other parts of the car, and, like it, its suitability for the service demanded is shown by the service rendered, which is perfectly satisfactory. One of the devices in use upon the car is the nut lock. It consists of a flat piece of sheet iron long enough to reach over two adjacent bolts, and punched to take the same. It is slipped on, and after the nuts are screwed home and squared with each other, the sides of this sheet-iron washer are turned up by means of a cold chisel, thus effectually locking both nuts and positively doing away with all possibility of turning.

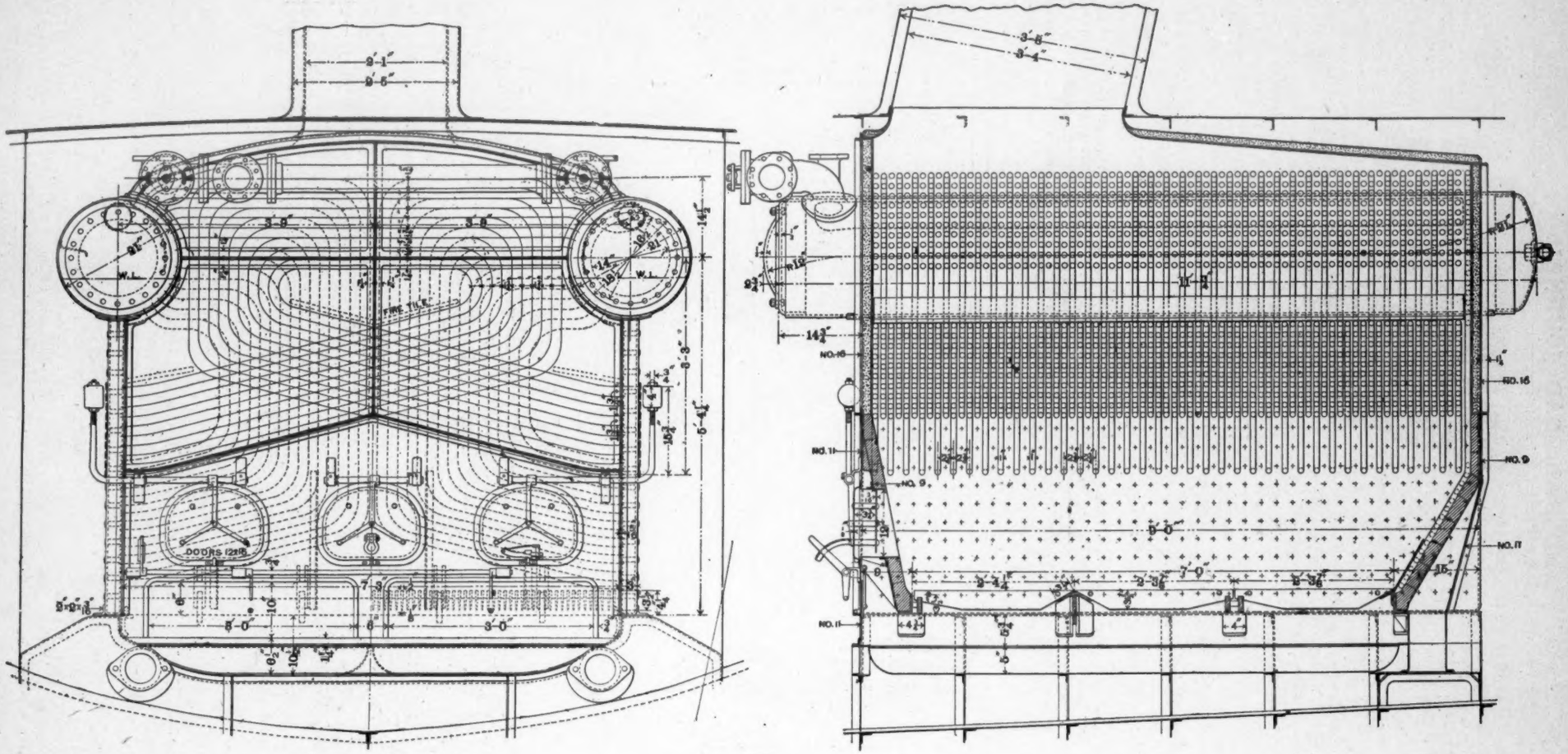
MACHINERY FOR THE NEW UNITED STATES TORPEDO-BOATS.

THE new torpedo-boats that are to be constructed for the Navy of this country, and which are at present known as torpedo boats Nos. 3, 4, and 5, are designed to have a speed of 24.5 knots per hour, at a displacement of 135 tons. They are to be driven by triple-expansion twin-screw engines built on the lines shown by the accompanying engravings. The two



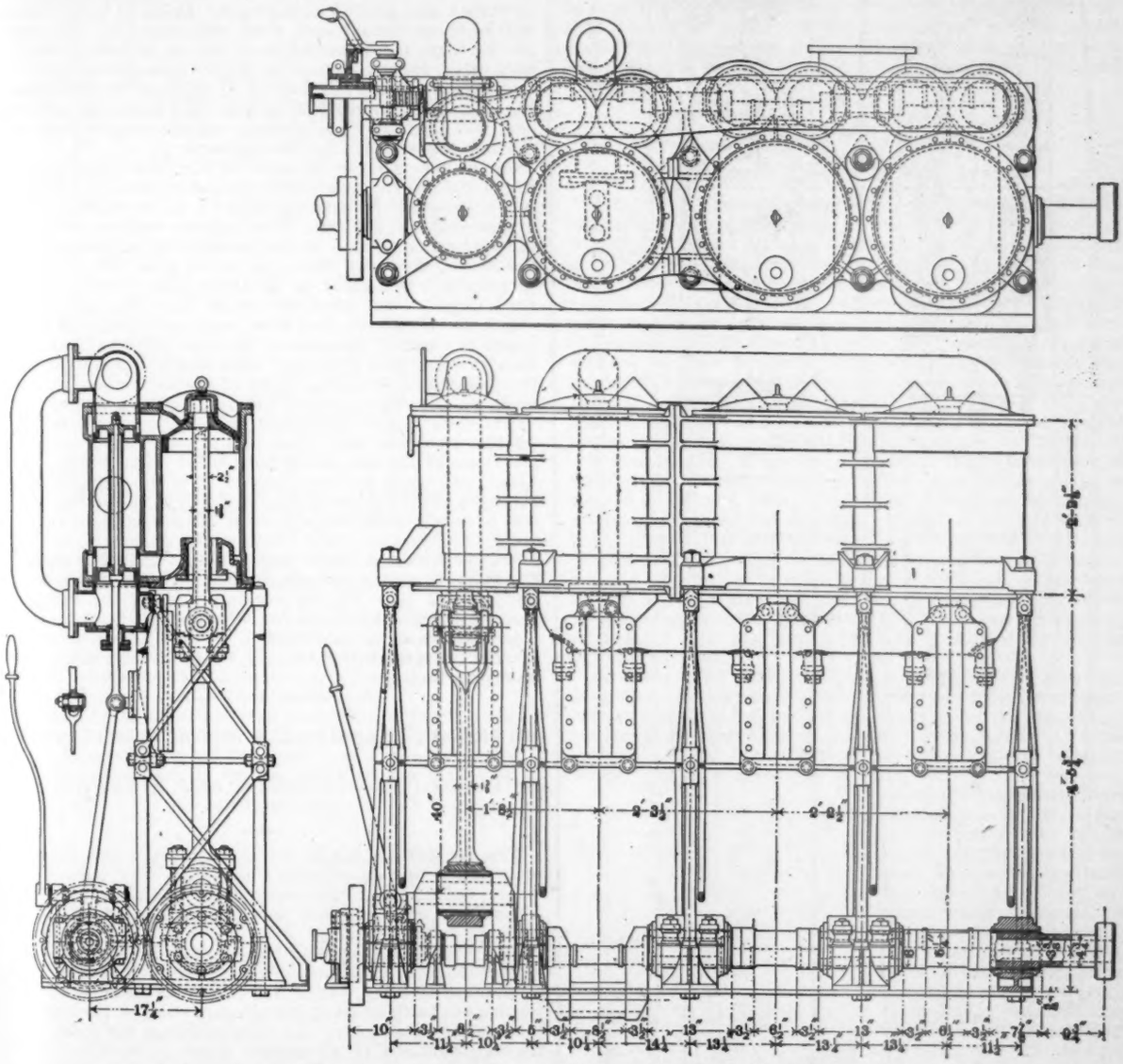
END ELEVATION AND CROSS-SECTION OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

engines will be alike, and each will be placed in a separate water-tight compartment. They will be of the vertical inverted-cylinder, direct-acting, triple-expansion type. The high-pressure cylinder will have a diameter of 12 in., the intermediate a diameter of 19½ in., and there will be two low-



WATER-TUBE BOILERS FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

pressure cylinders, each having a diameter of 23 in., the stroke of all of the pistons being 16 in. It is expected that the I.H.P. of the propelling engines will be about 2,000 when they are running at the rate of 412 revolutions per minute. As the two engines are alike, their positions will be reversed when they are placed in the boat. The starboard engine will have the high-pressure cylinder aft, while it will be forward in the port engine. There is also something of an innovation in the working of the main valves, which will be driven by means of cranks on a shaft parallel to the main engine shaft and geared to that shaft. Piston-valves are to be used for all of the main valves, there being one for each high-pressure, two for each intermediate-pressure, and two for each low-pressure cylinder.



PROPELLING ENGINES FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

Each main piston will be fitted with one piston rod that will be attached to a cross-head working in a slipper guide. The framing of the engines will consist of vertical forged steel columns well stayed by diagonal braces. The engine bed-plates will be of plate steel, supported on the wrought-steel keelson-plates that are built in the vessel. The crank-shafts will be made in one section, and will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild, open-hearth steel. The piston-rods, connecting-rods, and valve-rods will also be oil-tempered.

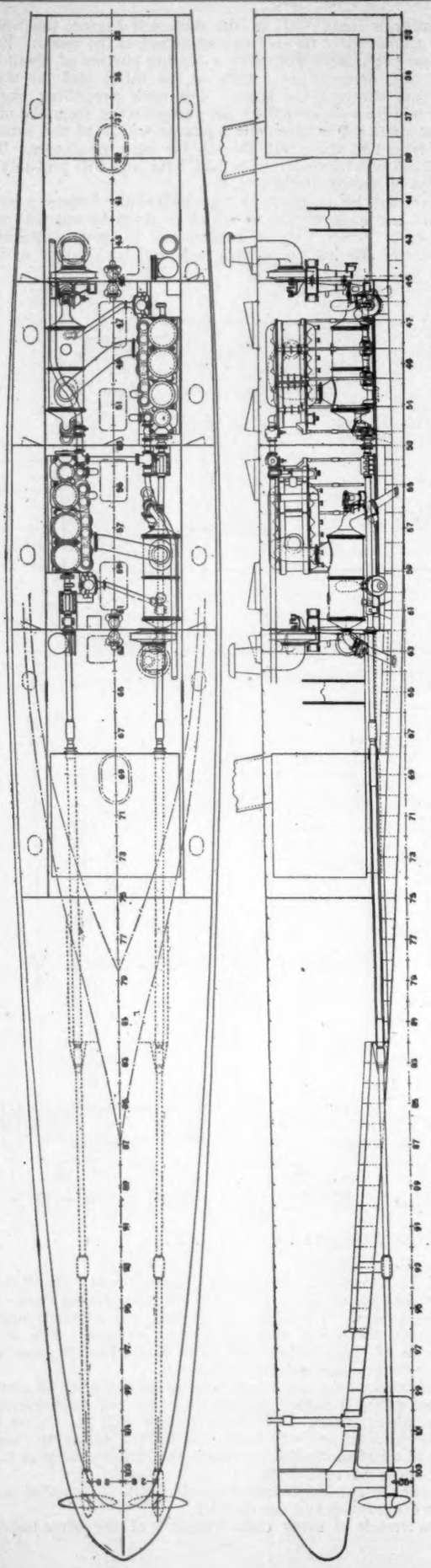
There will be a separate condenser supplied for each engine, and they will be located as indicated in the plan and longitudinal section of the arrangement of the machinery. It will be seen from this that the condenser for the starboard engine is placed forward of the port engine, while the condenser for the latter is located aft of the starboard engine, the water-tight compartment for each extending across the vessel. Each of these condensers will have a cooling surface of about 800 sq. ft. measured on the outside of the tubes, and the water will pass through the latter. For each propelling engine there will be a single-acting air-pump driven from the main engine-shaft. The circulating pumps will be of the centrifugal type, and there will be one for each condenser. The propellers will be made rights and lefts, and will probably be ordered of manganese bronze.

Steam will be supplied by two water-tube boilers, a longitudinal and cross-section of which is given by our full-page engraving. They will be constructed to carry a working pressure of 250 lbs. per square inch, and each boiler will be placed in a separate water-tight compartment; one being located forward of the engines and the other aft, as shown in the engravings. Locating the boilers this distance apart necessitates the use of two stacks, one for each. The total grate area of these boilers will be at least 95 sq. ft., and the total heating surface at least 5,120 sq. ft.

In addition to the main feed-pumps there will be an auxiliary feed-pump in each fire-room, and they will be duplicates of the main pumps. The main pumps will be placed in the engine-room, and will have a capacity equal to the supplying of all of the feed when the boilers are steaming at full power under a forced draft.

Among the auxiliary machinery that will be supplied will be two evaporators and one distiller.

As in vessels of every class weight is of the prime impor-



PLAN AND LONGITUDINAL SECTION OF VESSEL SHOWING THE ARRANGEMENTS OF THE MACHINERY IN THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

tance, it is specified that the total weight of all of the machinery for these boats, including boilers, auxiliaries and heaters, and water in the boilers, condensers and pipes, and such stores and spare parts as may be carried on board must not exceed 60 tons.

In regard to the details of construction, the specifications require that all of the crank, line, thrust, and propeller-shafts shall be of forged steel, and that each length shall be forged in one solid piece. The crank-shaft for each propelling engine will, therefore, be in one section. Each crank will, of course, have a throw of 8 in., and the shaft is to have a coupling disk $1\frac{3}{8}$ in. thick forged on to the after end. The crank-pins are to be $5\frac{1}{4}$ in. in diameter and $8\frac{1}{4}$ in. long for the high and intermediate cylinders, and $6\frac{1}{2}$ in. long for the two low-pressure cylinders. All of the journals and crank-pins are to be turned and ground to accuracy. Holes $3\frac{3}{8}$ in. in diameter will be bored through each shaft and crank-pin. The cranks of the high and intermediate cylinders will be opposite to each other, and the cranks of the low-pressure cylinders will be similarly placed, but making an angle of 90° with those of the high and intermediate cylinders. The sequence in the rotation will then be, high-pressure, second low-pressure, intermediate-pressure, and first low-pressure.

As the boilers are to be built for carrying a working pressure of 250 lbs. per square inch, the test pressure to which they will be subjected before being placed in the vessel will be much higher—namely, 360 lbs. This pressure will be obtained by the application of heat to fresh water that has been placed in the boilers, the water filling the boilers quite full. The same pressure will be applied to the steam-pipes, valve, and all of the fittings. Then, after the boilers have been placed in the vessel, and the connections have been made, they will be subjected to a second test under a pressure of 300 lbs. per square inch, in order that all of the leaks may be made tight before the jacketing is put on. Tests of the same severity will be made on the engine, where the high pressure cylinders and valve-chests will be subjected to a hydrostatic pressure of 360 lbs. per square inch, those of the intermediate to 180 lbs., and those of the low-pressure to 90 lbs. The pumps, valve-boxes, air vessels, and the pipes of all of the feed-pumps will be tested to 500 lbs. per square inch. The circulating pumps will be tested by discharging water under conditions as nearly as possible like those they will be working under when throwing water from the bilges, and will be required to discharge 750 galls. of water per minute under a head equal to that under which they will be working when in the vessel and discharging into the sea above the water-line.

In a future issue we expect to publish full particulars regarding the construction of these boats with reproductions of photographs.

NATIONAL MANUFACTURERS' ASSOCIATION.

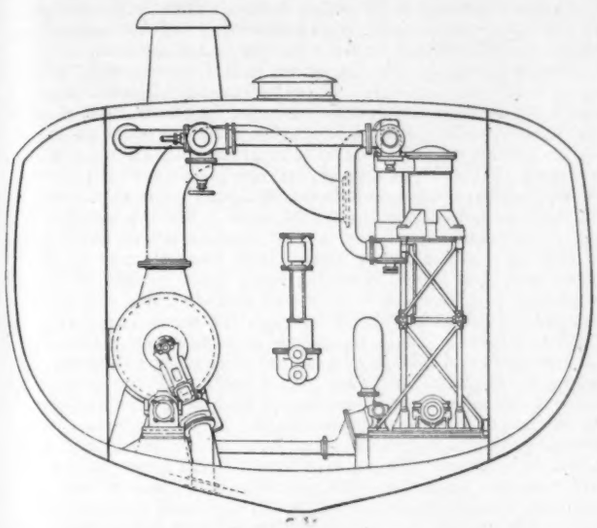
By Thomas P. Egan, President of J. A. Fay & Co., and the Egan Co.

The country has hardly yet realized that a new agency of great power is now at work; heretofore they have worked singly, but now the manufacturers of the United States are cementing themselves into an organization that will be far-reaching in its effects.

The industrial interests of this country have reached such magnitude as to make a national organization almost a matter of absolute necessity, as our manufacturers are now annually turning out twice as much in aggregate value as the total farm products of the country. An organization of this kind, bringing manufacturers of all sections together, working for the common good of all, without sectional or party interests to serve but simply the good of the country and of its industrial welfare at heart, can be made of incalculable value.

The men at the head of this undertaking are painstaking business men, and who have no "axe to grind" in a political way, and no preference for anything but what will be a benefit to the United States. When the recent tariff bill was under discussion, the manufacturers of the United States, it is true, made their protests; but it is also true their protests were made singly against the sweeping reductions in the tariff, and consequently carried little weight. In the future the manufacturers of the United States propose to speak as a unit through organization, and if this coalition had been effected before the Wilson bill was formed, we doubt if it would have carried the want, depression and woe with it that it has, for it would have been so modified that it could have been made an advantage, instead of a great disadvantage, to the United States.

The manufacturers of the United States, when in convention in October 15–17, at Chicago, propose to take this question up and discuss it effectually. From all the present indications, every State in the Union will be well represented by its very best manufacturers. The delegation from Ohio will be the equal of any from any State in the country. The vice-president for each State has the selection of the delegates, and the vice-president from Ohio proposes to use the best material that is presented, without regard to politics. The delegation from the southern part of Ohio will include such men as Mr. M. E. Ingalls, Mr. Charles Davis, Mr. E. C. Goshorn, as well as the Vice-President himself, Mr. Thomas P. Egan. The

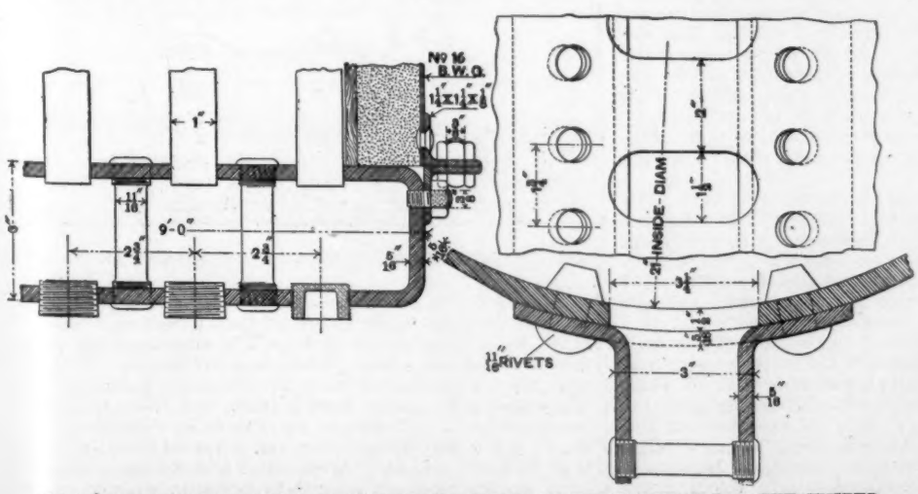


CROSS-SECTION AT ENGINE-ROOM OF THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

delegation from the northern part of the State will be picked with equal care, and accordingly the best men in the State will be selected.

The results of the convention of the National Manufacturers' Association, to be held in Chicago this month, will have a great weight in shaping the industries of the country affected by tariff legislation and the fortunes of the manufacturers of the United States, without the least regard to politics. The manufacturers propose never to allow themselves to be disregarded and their interests to be seriously affected by any action of Congress prejudicial to the good of the country without being heard from, as was the case when the last Congress rescinded the valuable reciprocity treaties which were then in force and framed a tariff under which it is almost impossible for the manufacturers to exist.

Any action by any of the political parties of this country which hurts the manufacturer, hurts the workman in an equal if not greater degree. Let us hope that the convention of the National Manufacturers' Association to be held in Chicago in the fall, from which so much is expected, will handle matters fairly, and consequently for the best interests of the people in general. Much is expected of this convention, and it will be a great disappointment to many if it does not rise to the occasion. It will be composed of about 450 representative delegates, representing all the business sections of the country. It will be a far different one from the one held in Cincinnati, which was, of course, merely preliminary, for every manufacturer who could come registered his name; but now each State will have its proportionate number of representatives, which is five from each State, and then each State is entitled to one more delegate for every $50,000,000 of produce, which is to be governed by the last census. By this means all will have an equal representation in their proportion as to production. We trust that every vice-president for each State will exercise the greatest care in the selection of delegates, so as to make up one of the most representative bodies of manufacturers ever held.



DETAIL SHOWING METHOD OF FASTENING TUBES IN THE BOILERS FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

AMONG THE SHOPS.

THE GRAND TRUNK SHOPS AT MONTREAL.

THE Grand Trunk Railway is in a situation peculiar to itself and one not at all similar to any other on this side of the Atlantic. Located as it is in Canada, it is cut off from the manufactories of this country by the bar of the Canadian customs duties. Under these circumstances, then, the management have found it to be advisable to manufacture a far larger proportion of its own supplies than would be the case were it possible to buy direct from the American manufacturer without the intervention of the duties, which so raise the cost to the railroad company that it has been found to be more economical to put special machinery into their shops and enter upon an industry on a scale that would not have been thought of had circumstances and purchasing facilities been better.

The main shops of the company, where the major portion of their work is done, and from which supplies are issued, is located at Point St. Charles, in the city of Montreal, and occupy a tract of 40 acres; the buildings themselves cover 11 acres of this ground. The buildings are all of one story in height, and though they have been erected from time to time as the necessities of the work to be done has demanded, and without any reference to a prearranged plan, they are convenient and readily accessible from one department to another, and the handling of material is so provided for that there is no delay or extra expense entailed.

In the material used, a complete cycle seems to be traversed; starting from new stock through the various stages of wear, tear and repairs, we find ourselves at last by the scrap heap, whence the old iron emerges, like the phœnix, to do duty again as new material in the shape of bar-iron axles and forgings. Perhaps, then, it may be as well to start in at the scrap heap, where the road has an extra large amount of iron. Years ago, when the steel rail began to supplant the iron for main line work, the latter was relaid in sidings and spurs, where it has served its purpose until the once new steel began to show signs of wear and required replacing. As iron is much more readily handled than steel, the old iron sidings are being torn up, steel put in the place, and the iron sent to the company's mill for reworking. The scrap-handling department of the mill is, perhaps, its most interesting, if not the most important feature. The old boiler plate is heaped up at one end of the scrap-working shed, the old rails come in at one side, and the smaller scrap is piled up in one corner. The latter is piled upon shingles to the amount of about 200 lbs. and is then heated and hammered in the ordinary way. The rails come in on a long slide like a runway for logs, and are cut off to lengths of about 3 ft., and then fagotted for welding. In this scrap shed there are four sets of shears driven by three steam engines that are integral parts of the machines. Three of the shears

were built by a Canadian manufacturing firm, and the fourth, which is the largest, was built by the company at their own shops. This shear is driven by its own engine and has a cutter 6 ft. 6 in. long. It is used for boiler plate and taking the flanges off from the lengths of rails after they have been cut to length. The rolling mill is equipped with three heating furnaces, a 3,000-lbs. steam trip-hammer with a 28-in. cylinder, a 3,000 lbs. steam hammer with a 14-in. cylinder, a set of shears for cutting bar iron to lengths and a train of three-high rolls that are capable of rolling bars up to 6 in. × 1 in. or 9 in. × ½ in.

The material that is manufactured here embraces all the bar iron up to the size of the roller limit that is used by the road and the locomotive and car axles. These are issued to the several departments and shops, which are charged with everything delivered at a fixed rate.

Passing from the rolling mill, we come directly into the car shops. These shops consist practically of one long building divided by partitions into the several working departments. At one end is the planing-mill with its dry kiln for working the soft woods. It has the usual equipment of wood-working machinery, with blowers for conveying the shavings to the fire-room. This system of blower pipes is carried to all the other wood-working tools, so that the shop is kept clean with the minimum amount of manual labor. It may be noted here, also, that as the details of the freight equipment has been standardized, it is possible to keep a large reserve of material on hand ready for use, and that the introduction of the piece-work system has been greatly facilitated thereby. This system has been applied to all parts of the regular manufacturing, and is apparently satisfactory to both parties to the agreement.

Next to the planing mill is the machine shop for car work. It is unnecessary to recapitulate the tools in use in any of the several departments, as they are of the standard types common to all car shops. But there is some work done here, as we have already hinted, that is not usually found in railroad shops. For example, in the bolt and nut department, in addition to the usual work, all of the lag or coach screws in use upon the road are made. They are cut by the piece, the price varying with the size of the bolt or screw. It is in this shop that we are first brought into contact with the very elaborate system of overhead trolleys and floor tracks used for the transferring of material from tool to tool. The latter are narrow-gauge tracks of heavy flat iron that run the whole length of the shops, are provided with numerous turnouts and cross tracks, the latter being connected with the main line, as it were, by a flat-top turntable, upon which the flange of the wheels run, and which are therefore always in position for use, and which are so designed that they turn with the minimum amount of push on the part of the workmen. These tracks are used for conveying heavy or bulky material or large quantities for a distance. The overhead trolleys are of the single-rail type made of a piece of 3 in. × ½ in. flat iron on edge, over which a single-wheel trolley runs, and from which is suspended a Weston chain hoist. These are placed wherever there is a consecutive passage to be made of material from one tool to another. For instance, there is a crooked line that takes in the storage floor for axles, the wheel presses, axle lathe, and cutting off and centring machine for axles. The wheel borers are of course fitted with their own hoists. Here we again come into contact with tools built by the company, and this seems to have been done wherever the price of the foreign-built tool plus the duty on the same would render it advisable.

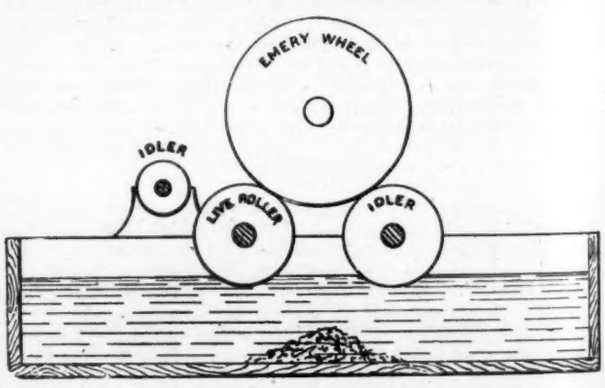
It is in one corner of this machine shop that we come upon the second industry, considering the rolling mill to have been the first, that is not a usual accompaniment of a railroad shop. All of the wire nails used by the road are made in this shop by four machines that have a capacity ranging from 70 to 250 per minute, according to the size of the product. The rods are, of course, bought from the manufacturers.

While dealing with the machine shop the subject of wheels and couplers is naturally suggested. Up to the present time the Grand Trunk Railway has adopted no type of the M. C. B. coupler, but is still using the link-and-pin coupler with the yoke connection for the spring. It is not expected that this state of affairs will continue for any great length of time longer, and they are expecting to swing into line. When they do, however, it is their intention to erect suitable foundries for turning out their own equipment. The cast-iron wheels used by the road are made at the company's foundry at Hamilton, and the steel-tired wheels are imported from Germany, and are of the Bochum type with Mansell retaining rings. A considerable number of 42-in. wheels are used. The axles, as we have said, are hammered from scrap on the premises, and are of the M. C. B. standard dimensions according to the car under which they are used.

Next to the machine shop, and with no dividing partition to separate the two, is the general wood working shop. Here the special tools made by the company also appear. Principal among them is a set of checking tools for checking belt rails, bolsters and the like at a single operation. As standards for car framing are so dissimilar, and as there is so little demand for tools of this type, there is nothing on the market that will do the work, hence these tools were home-made, drawings of which are now in our possession and will appear in a future issue. It may be added here that all of the checking for the pieces named is done at a single operation. Here, too, the overhead trolley is in evidence and serves to handle all of the heavy pieces, such as sills and bolsters, to and from the machines.

At the lower end of this shop is the cabinet shop, where all of the finer work is done, where doors and window sashes are made, and the veneer for head linings manufactured.

Next and last on the list as we pass down through the car shops is the erecting shop. Here there are three lines of tracks, upon two of which there is ample room for the erection of five 50-ft. cars, while the third is shortened by the space occupied by the plating and upholsterer's departments. In the plating room all of the brass fittings for the passenger cars are finished, the castings are made in the company's foundry, and are finished, buffed and plated in this room. The introduction of this department has effected a most marked saving in the cost of fittings. In one case a plate which formerly cost $1.25 is now made for about 22 cents; some spun shields of sheet brass that cost 90 cents to buy now cost 30 cents, and so the comparison might be carried through the whole range of car fittings, which is made to include not only door plates, bell cord hangers and fittings of a similar character, but locks, car lamps, headlight reflectors and parcel racks. Of course such a place as this cannot be without its own special devices, and one is the method of cleaning lamp burners. Any one who has tried to wipe one clean knows the trouble involved; boiling in water is but little better. Here a man hangs a half dozen on a wire and immerses them for a few moments in a kettle of hot lye, then they are dipped in a solution of nitric acid and sulphuric acid—only just dipped in—then plunged into and thoroughly swashed about in cold water, heated in a bath of boiling water, dropped into dry sawdust, from which they emerge as bright and shining as though they were just from the hands of their maker. The time occupied is about five minutes for the batch. The plating is done in the usual way, except in the case of headlight reflectors, where the reflector itself is made to serve for the bath. It is filled with the solution, which, after the plating is completed, is turned back into the bath. The shop



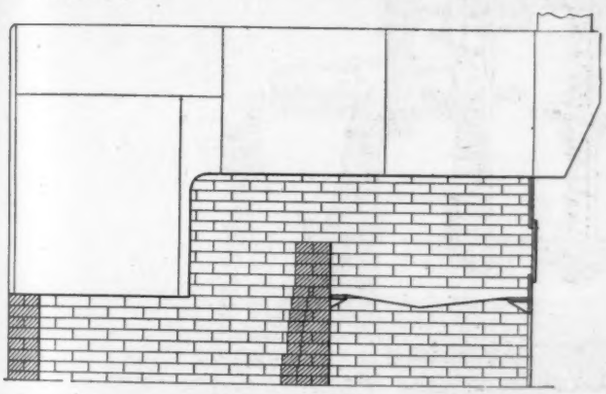
APPARATUS FOR REMOVING EMERY FROM POLISHING WHEELS.

is also fitted with a small gas furnace for making solder, and a little device for taking emery off from polishing wheels that saves time, labor and material. The accompanying sketch shows the whole affair. There is a live wooden roller that dips into a water bath, and on either side of it there is an idler. The wheel to be cleaned is set between two of the rollers, and is kept moist by the water on the live roller. In this way the emery is washed off and falls to the bottom of the tray, whence it is removed, and after being dried and sifted is used again, while the leather is not injured by excessive wetting. In the upholsterer's room the car seats are made and repaired and soiled plush dyed.

The building in which the foregoing work is done is built without any post supports for the roof, but with a clear span from wall to wall, so that everything is free for the work to be done and the handling of the material used. The windows are large and set close together, and, what is of perhaps as much importance, are kept clean. The roof is white and

fitted with a wide monitor, so that the shop is well lighted, and even between the tracks, when all are occupied, there is not a suspicion of duskiness even upon a cloudy day.

South of this main building stands the repair shop, where all sorts and conditions of weaknesses are displayed. The building contains a line of six tracks, with posts supporting the roof between each two lines. It would be interesting to make a study of the inherent defects and strong points of the cripples sent to this hospital for rehabilitation, and if some car-builder would but make a systematic study of what is done in such a place, it would be a valuable contribution to the literature of car construction, and materially assist in the development of the car of the future, that should be like the deacon's one-horse shay, so equally strong in all its parts that nothing could give out first; and when the final collapse did come, the whilom car would seem to have been to the mill and ground. But in these shops there is the usual array of strong and weak constructions that are to be found in the "bone yard" of every trunk line. The shop requires no special tools, and it has none other than the usual complement of jacks and hoists. It seems, though, that far better provision is made for doing "bone-yard" repairs under cover than is usually the case, probably owing to the severity of the Canadian winters, where out-of-door work of this sort is rendered impossible for many months at a time.



ARRANGEMENT OF FURNACE FOR LOCOMOTIVE-FORM BOILERS.

There is a special building provided for doing the work of shrinking on of tires. This building is round, or rather sixteen sided, and contains a rack with gas and air-blast accessories for heating, and a crane standing in the centre of the building covers the whole floor with its boom. Here, too, are a couple of ordinary forges for doing the minor blacksmithing work connected with repairs and special jobs.

The paint shop is supplied with three trucks, each capable of holding eight passenger coaches, and well lighted both from the sides and roof.

Power is supplied to the car shops by eight locomotive-form boilers that have been converted into return tubular boilers by the very simple device of building a brick furnace under the shell and carrying the flue back and beneath the regular fire-box, which thus forms a most perfect combustion chamber, as shown by the accompanying sketch. These boilers are all fired with the refuse from the car shops, and the firing is done by hand. Six boilers are sufficient to supply all the steam that is needed, two being kept in reserve.

Some time ago,* in commenting upon the shops of the Philadelphia & Reading Railroad, we called attention to the remarkable freedom from sulphurous gases that prevailed in the blacksmith shop, due to the use of suitable hoods over the forge fires. This is even more noticeable in the shops under consideration, in that the natural ventilation of this building is poor; and yet there is not the slightest trace of sulphur about the premises. The hoods are built of brick and entirely cover the forge, and yet are high enough to permit of entire freedom of action on the part of the smith. The blacksmith shop also has a number of oil-heating furnaces that are used for special work, burning crude oil with a Burns burner. The power for the blacksmith shop is supplied by a portion of an old inside-connected locomotive. The frame has been cut off just back of the main driving-axles, the links removed, and the eccentric-rods connected direct to the lower arms of the rockers. It is the last step in the utilization of an old piece of machinery that has outlived its original purposes. Even one of the driving-wheels has been retained in position, the rim grooved and a V-belt applied to drive the shafting. This utilization of old locomotive parts is current practice here, especially in the matter of boilers, where those condemned for the higher pressures and greater strains of locomotive service are utilized for stationary work.

The Grand Trunk might almost be called an English railroad transplanted to American soil. Many of the officers received their training in the old country, and it is not strange that the practice of the road should be tinged with English ideas. Indeed, it is to be wondered at that these ideas are not more pronounced than they are. English machinery naturally takes the place of American if it can be bought for a lower figure, for this price has the twofold influence of actual cost and the duty, which is an *ad valorem* one, and places a practical embargo upon goods made in the United States. The first shop where this appears in a pronounced shape is the boiler shop, which, with the exception of a Worthington hydraulic pump, is entirely equipped with English tools. There are the well-known Tweddle hydraulic riveters, both stationary and portable, hydraulic punches by the same firm, and a very fine planer with a travelling head that is reversible, so that it cuts in both directions, for planing the edges of boiler sheets, the whole being capped by a fine hydraulic crane of five and 10 tons capacity of the Tweddle design that has a lift of 27 ft. in the clear from the floor and a radius of 22 ft.

In the machine shop the same condition prevails, the heavier machinery having nearly all been purchased in England or Canada. There is one noticeable feature about this foreign built machinery that American manufacturers and American users would do well to imitate. It is the care with which shields or coverings are placed over all moving parts that are in any way likely to catch the clothing or person of the workman. With us it is a regrettable fact that gearing is allowed to run loose, as it were, without even the faintest pretext of a covering, so far as forming a portion of the machine is concerned; and it may be said that it is only occasionally that even a railing is erected that serves to prevent the unwary from falling into the trap that seems to have been set for them. With the English and German machines, on the other hand, every precaution is taken to guard against such accidents, which results not only in gaining the object aimed at, but in giving the tool a neater appearance.

The erecting shop consists of 40 pits, with no provision for overhead hoisting, and at one end only is there an arrangement for hoisting engines for placing the wheels beneath them. These 40 pits are placed on either side of the shop, and are separated by a shallow pit over which a transfer carriage is made to travel. The machine shop is a counterpart of those of most railroad shops where the requirements have to a certain extent outgrown the capacity, and the tools are somewhat crowded. There are a few special tools that have been built on the premises, among them the link grinding machine that was illustrated and described in our issue for May, 1895. This tool grinds the link and block to a true radius after they have been case-hardened, and does its work so accurately that blocks move with perfect freedom from one end of the link to the other, whether in their proper position or reversed.

The shop is also showing evidence of the introduction of compressed air, and a number of hoists running on overhead tracks similar to those in use in the car shops are employed. The compressed air is supplied by a compressor made on the premises from old cylinders that were useless for other purposes.

Contrary to the practice of many roads, the Grand Trunk make all of their own castings both in iron and brass. Both foundries are fitted for both hand and machine moulding. There can be nothing very novel in the methods pursued in variation from those employed elsewhere except in the details of the arrangements and the construction of the moulding machines. After a careful investigation of the machines now upon the market, it was decided that the peculiar conditions of work required a modification of the machines offered; and so, while there are some machines in use that were purchased direct from the makers, the road has built others with some modifications which adapted them to their work, and which we will illustrate in a future issue.

The tour of the shops having been completed, it now remains to note the outside attachments that are a part and parcel of the whole, but do not necessarily belong to the manufacturing departments.

We have said that the management of the road is tinged with English practice, and this appears most prominently, perhaps, in the use of a running shed in place of a roundhouse. There is a cross-shaped building on the premises with a turntable in its centre and tracks leading radially off therefrom that is to all intents and purposes a roundhouse, but it is old and low, and would not be rebuilt in its present form were it to be destroy-

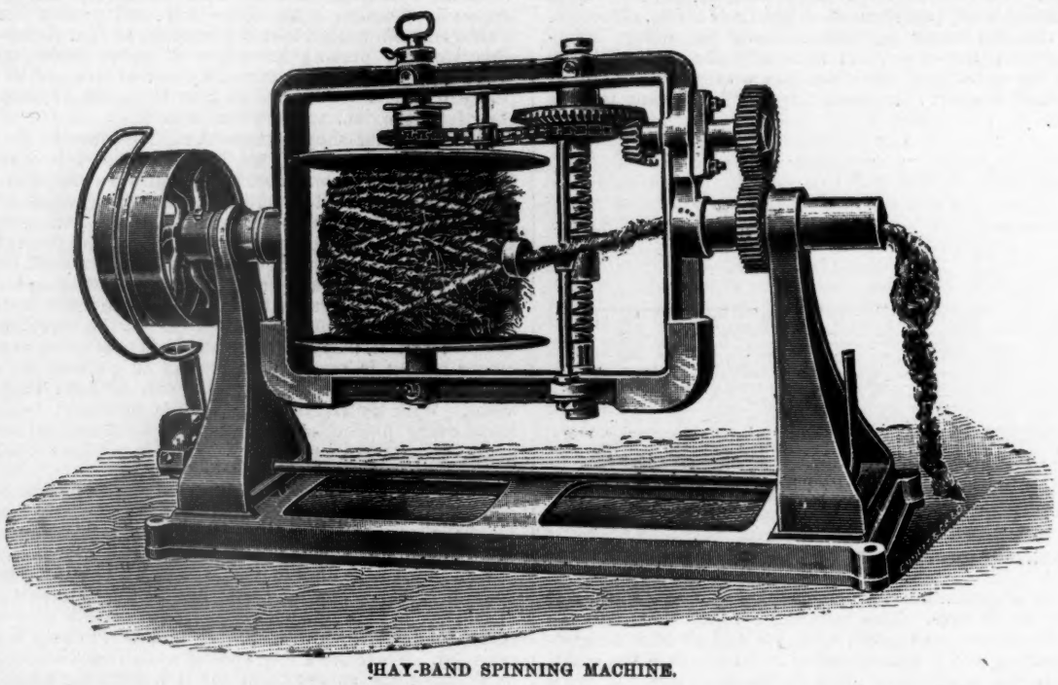
* See AMERICAN ENGINEER AND RAILROAD JOURNAL for November, 1893.

ed. The real locomotive house is a fine long running shed with four tracks running the entire length, having pits that are well drained and heated with steam. Overhead there is an inverted trough for catching and carrying off the smoke, and which is hipped up at intervals of about 35 ft. to stacks for carrying off the smoke. On the occasion of our visit the building was nearly full, but there were no signs of any trouble from the smoke, and we are told that there is none in the winter, when everything is closed. Speaking of the desirability of the running shed in comparison with the roundhouse, the management are most emphatic in their preference for the former. It is claimed that where engines are run first in first out, that the rotation is natural, that they are more easily handled, and that in case of fire the danger of heavy loss is reduced to a minimum. Such testimony is more valuable coming from this source than it is from the English roads, in that the roundhouse is still extensively used on the Grand Trunk, and the present running shed was preceded by a roundhouse.

delivery of lectures, the institution of classes, and the providing of specimens and drawings."

Any employée of the company may become a member upon the payment of dues that are 10 cents a month, and this entitles him to draw books—except books of reference—from the library and retain them for 14 days; to have access to the reading-room and to all the privileges of the building, which includes hot and cold baths, the use of the lecture hall at noon for lunch, the lectures and entertainments. This lecture hall is a large room, with tables and benches that can be used for lunching, and a heating chamber, in which the lunches of the men are warmed for them. At one end of the hall is a stage well equipped with stock scenery, and upon which the dramatic ability of the members has a chance to display itself. At present there are about 700 members, and the records show that something more than 16,000 volumes were drawn during the year ending December 31, 1894.

From what we have written, it will be understood that these



HAY-BAND SPINNING MACHINE.

Among the outside attachments is the fire service. There is a regularly organized fire brigade with an engineer in constant attendance, and hose carts that are manned by employés in the shops when an alarm is given. They are regularly drilled, and at intervals about the buildings and yards there are signal stations from which notice of a fire can be sent to the headquarters of the company's brigade as well as to that of the city fire department. Water is supplied by mains under pressure, so that no fire engine is needed, and a hose attachment to a hydrant is all that is required in order to throw a powerful stream.

Back of the hose-room is an accident-room, with all of the appliances for dressing wounds and caring for the patient. A telephone connection enables a physician to be called at once, and arrangements have been made with several to respond to calls, so that one is always available. In connection with this department there is an insurance society, in which every employé is obliged to take a policy. The rates are something less than $30 a year for $1000, and policies are issued for from $250 to $2,000. The physical examination for this is practically the same as that of the regular line companies.

A valuable adjunct to the shop is the reading-room and library; it is technically known as the Grand Trunk Railway Literary and Scientific Institute, and is supported by a grant from the railroad company and dues from the members. A fine room is furnished by the company, in which is placed a library of 6,467 volumes, comprising works on architecture, electricity, engineering, mathematics, agriculture, geology, natural history, hygiene, astronomy, natural philosophy, history, biography, travels, poetry, novels, books of reference, magazines and reviews. It was founded in 1857, and in 1871 received a corporate charter. The object, as laid down in the constitution, is "to supply its members with the means of instruction in science, literature and the arts by the establishment of a reading-room and library, for the use of its members, the

shops occupy the unique position of being a little world by themselves, cut off to a certain extent from the supplies of the manufacturing countries, and thus compelled to depend upon its own resources to satisfy its own wants. The officers have, therefore, been forced to design and construct many machines that under other circumstances would have been bought in the open market. In the course of our description we have alluded to a few of these machines, of some of which we shall publish engravings and descriptions in future issues.

HAY-BAND SPINNING MACHINE.

THE illustration given herewith represents a machine for spinning hay and straw bands used principally in the foundry for core making, and also extensively for packing ironmongery, furniture, etc. In the old method of making bands the twist is put in by the turner using a cranked handle with a hook at the end, while the core maker strings or "roves" the hay or straw together. This has three important drawbacks. The first is the slowness of the operation—say, 60 or 70 turns per minute being good work to maintain. The second defect is that the length of the bands thus produced is limited, 30 yds. being a good length (and this is not always available in a foundry), and therefore to cover a fairly large core it requires several lengths. The third demerit is that the bands cannot be twisted hard. A soft band or a band soft in places is objectionable, because when the metal is poured, and especially with deep castings having a great pressure at the bottom, the band does not support the core, but is crushed in to some extent, making the interior of the bore rough and irregular. These inconveniences are, it is claimed, altogether obviated by making the bands by the machine represented, one of the merits of which is that it only requires the services of one

man, who can make bands from ¼ in. up to about 1¼ in. diameter, the thickness being regulated by the amount of material the operator passes through the machine. The frame makes about 140 revolutions per minute. As will be seen, the saving in floor space is a consideration, no rope-walk being required; also the band can be readily removed from the machine without unwinding. Further particulars will be readily supplied by the maker, Mr. James Pollard, Atlas Works, Burnley.—*The Mechanical World.*

TANK LOCOMOTIVE FOR THE NEW YORK AND BROOKLYN BRIDGE.

H. K. PORTER & Co., of Pittsburgh, Pa., have recently built some tank locomotives for use on the New York and Brooklyn Bridge that are heavier than any that have heretofore been used in that place. As the work done by these locomotives is switching work of the severest kind, it is necessary that they should be built in the strongest and most substantial manner. Accordingly the frames used on these engines are like those used upon one size heavier locomotive as ordinarily built by these makers.

One of the peculiarities of the engine is that upon the right-hand side a pump is placed instead of an injector. This was done as a precautionary measure to insure the positive feeding of the boiler in case of an accident to the injector due to the jarring over the frogs or for any other reason. In the suction-pipe of the pump and just beneath the running board there is placed a small cast-iron box, into which a boiler-cleansing compound can be introduced through an opening that is usually closed with a gas-pipe plug. The compound is thus pumped into the boiler with the first flow of water. A charge put in once a week, and a blowing down of the boiler from a full condition to the first gauge just before the cleanser is pumped in, serves to keep the boiler free from scale, which would otherwise be a carbonate of lime from the water used. This is about all the work that the pump is called upon to perform; the injector on the left-hand side being ordinarily used for feeding.

Beneath the foot-plate, on the right-hand side, there is a cast-iron box of about 2 cub. ft. capacity, with a drain-pipe supplied with a globe valve. This box is used to catch the waste from the gauge-cocks, the relief from the pump, and the overflow from the injector, so that there is no slopping of water about the depot, and is emptied when the engine is run over the pit.

The pony trucks under these engines are fitted with a new device, whereby on curving a pair of rollers that carry the weight are made to roll up an incline, with a constant tendency to return and draw the truck back into its normal position. It is expected that engines of this type will be adopted as a standard for the bridge work, which will be more severe than ever after the present terminal alterations are completed.

The following is a list of the principal dimensions:

GENERAL DIMENSIONS.

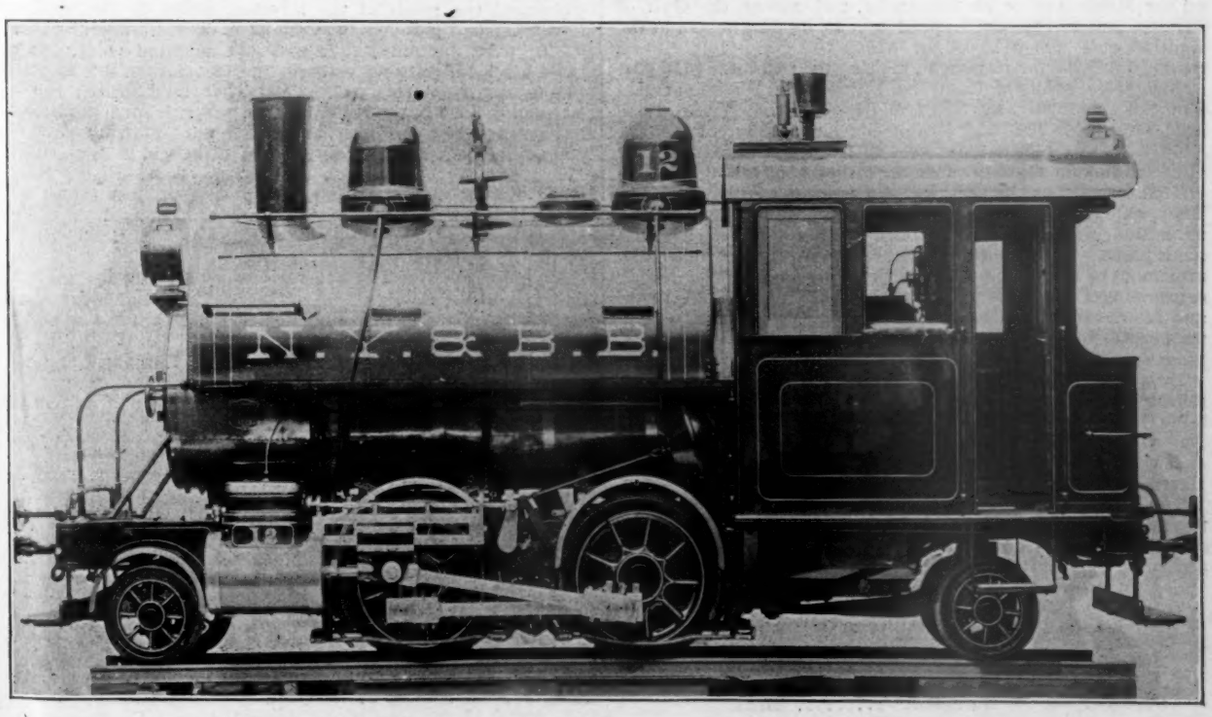
Type of locomotive, four driving-wheels, with two-wheel front truck and two-wheel rear truck.	
56½ in. gauge track.	
Cylinders, simple, not compound.	
Anthracite fuel.	
Total weight, 79,900 lbs., with 57,400 lbs. on the truck-wheels.	
Rigid wheel base	5 ft.
Total wheel base	18 ft. 11¼ in.
Length over all, not including drawheads, 24 ft. 1 in.; or, over drawheads, 28 ft.	
Extreme height of stack above rails	12 ft. 7 in.
Heating surface, fire-box	61.5 sq. ft.
" " tubes outside	625.0 sq. ft.
" " total	
Grate area	15 sq. ft.

WHEELS AND JOURNALS.

Drivers, number	4
" diameter	42 in.
Truck-wheels, diameter	26 in.
Journals, driving-axle, size	7 in. × 7½ in.
" truck " "	3¾ in. × 6 in.
Main crank-pin, size	4 in. × 5½ in.

CYLINDERS.

Cylinders, diameter	14 in.
Piston stroke	18 in.
Balanced slide valve with relief valve.	
Type of boiler	Straight top.
Working steam pressure of boiler	160 lbs.
Number of tubes	166
Out-side diameter of tubes	1¾ in.
Length of tubes over sheets	99 in.
Fire-box, length	59 in.
" width	36¾ in.
" depth, front	43½ in.
" " back	38 in.
Kind of grates	Water-tube and wrought-iron bars.
Diameter of smoke-box	48 in.
Length " "	47 in.
Taper stack.	
Capacity of water-tank	1,000 galls.
Coal capacity	1,750 lbs.



TANK LOCOMOTIVE FOR THE NEW YORK AND BROOKLYN BRIDGE.

NAVAL AND MARINE NOTES.

A Naval Experimental Tank.—The Chief Naval Constructor will, it is said, urge upon the next Congress the need of an experimental tank for testing the resistance of various forms for ships, models of which will be built Suct.

tanks have been constructed and are in constant use in the Navy Departments of England and France and in some private shipbuilding yards on the Clyde, where their commercial value, it is said, has been fully demonstrated. The British Admiralty have had for several years three or four skilled officials constantly on duty at the experimental tank at Haslar, and no new design is laid down until full trials have been made of the model and accurate information obtained upon which the future performance of the vessel may be reliably predicted. An appropriation of $100,000 will suffice for the complete installation of a plant of this kind, including all necessary structures.

Tests of Creusot Armor Plates.—In April last the Royal Navy Department of Sweden awarded a contract for armor plates to Messrs. Schneider & Co., of Creusot. The plates are intended for the new vessel, the *Oden*. The one that was recently tested was 2 metres (6.56 ft.) long by 1 metre wide (4.92 ft.), with a thickness of 0.25 metre (9.84 in.). According to the terms of the contract, it was called upon to sustain three shots from a gun having a calibre of 15 centimetres (5.9 in.) throwing a chrome steel projectile forged at Finspong, and meeting the requirements of the Swedish Navy; the same to weigh 99 lbs., and to have a velocity at the point of impact of 1,850 ft. per second. Under these conditions no portion of the shot or the plate was to be forced through the target; the first shot was to produce no cracks, and the other shots must detach no pieces that would leave the crew exposed. The three shots were fired into the apeces of an equilateral triangle having sides equal to about 3½ calibres and 4.8 ft. from the side, located in the centre of the plate, the base being horizontal. None of the three shots produced any crack in the plate, each one having rebounded to from 14 ft. to 18 ft. After the trial the plate was removed from the target to which it had been fastened by 12 bolts, and only a slight bulging and crack was visible at the back. The plates thus greatly exceeded the specifications, and the shot which suffered only a very slight distortion evidenced the excellent quality of the work done on projectiles at Finspong.—*Le Yacht.*

Three New Torpedo-Boats.—The act of Congress authorizing the construction of the three new boats provided that only one if possible was to be built on the Pacific Coast, one on the Mississippi or its tributaries, and one on the Gulf of Mexico, and the required speed was to be 26 knots, and the limit of cost was $175,000, of which the Navy Department reserved $25,000 for armament, making the real limit $150,000.

Bids were received from the Union Iron Works, of San Francisco, $175,000, the Wolf & Zwicker Iron Works, Portland, Ore., $168,700, and Moran Bros. Company, of Seattle, $163,350. No bids were received from the Mississippi or Gulf of Mexico region. The Herreshoffs, of Bristol, R. I., offered to build one or all three of the boats at $144,000 each. They were, however, to be built on plans which the company submitted, whereas the other bids were on the Navy Department plans. It is not said whether these prices included the armament or not. The New York *Sun* reports that a board, comprising Commander Converse, Naval Constructor Clapp, and Lieutenants Fletcher and Smith, convened at the torpedo station at Newport on September 16, to prepare a report on plans submitted by the Herreshoffs for torpedo-boats, and on which these noted builders submitted the lowest bids in the recent contest. It is understood that the Herreshoff plans, aside from the low bids made, are quite acceptable to the Navy Department, and that it is to determine the value of one or two innovations and minor changes suggested by the Herreshoffs that the special board was convened.

The following list gives the names, the speeds of various torpedo-boats, and that of their builders, from which it will be seen that 26 knots now cannot be regarded as being extraordinary:

Hornet,	by	Yarrow.....	27.6	knots.
Havoc,	"	"	27.	"
Daring,	"	Thorneycroft..... ...	29.268	"
Ardent,	"	"	29.182	"
Adler,	"	Schican.....	27.4	"
Chevalier,	"	Normand.	27.22	"
Boxer,	"	Thorneycroft.....	29 3	"
Sokol (Hawk),	"	Yarrow.....	30.285	"

PERSONALS.

Mr. H. M. Norris, whose name is more or less familiar to our readers, has accepted the important position of Superintendent and Mechanical Engineer of the Riehle Bros. Testing Machine Company, engineers, founders, and machinists, Ninth Street above Master, Philadelphia, Pa. Mr. C. E. Buzby, who for a number of years has been their Superintendent, is about to retire from active business, but will remain with them in the capacity of consulting engineer.

E. E. Keller, of the Westinghouse Machine Company, has just returned from Europe, where he obtained for his company all American rights in the Parsons steam turbine. It is just what its name implies, a turbine or rotating wheel, like a water-power wheel, only that it is driven by steam instead of by water. The steam is transmitted direct from the boiler against the turbine, striking it with great force. The turbine rotates and is connected by shafting with the electric generator, which is to furnish the power desired. It is claimed for this kind of turbine that each 15 lbs. of water in the boiler will generate 1 electric H.P., which is a very remarkable efficiency.—*Pittsburg Despatch.*

Mr. L. B. Sherman, for many years connected with the *Railway Review*, of Chicago, has been appointed Western Manager for *The Official Railway Equipment Guide* and *The Pocket List of Railroad Officials*. Mr. Sherman assumed his new duties on September 1, 1895, with headquarters 425 Rookery, Chicago.

EDWARD F. C. DAVIS.

At a meeting of the Council of the American Society of Mechanical Engineers, held August 26, resolutions were adopted expressing the respect and regard of its members for the late President, whose sudden and untimely death has been so deeply mourned. "His wise and mature judgment," it is said in the resolutions, "his business and professional knowledge, his conservative yet energetic counsel, and his courteous consideration for others, had made him one from whose administration for the Society's affairs the highest hopes had been entertained."

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The Secretary has published the result of the informal ballot on the modified recommended practice in grab-iron or hand-hole location. There were 653 affirmative and 320 negative votes, but as there are 1,477 possible votes in the association, it is impossible to say from this test ballot what modification can be adopted in 1896 in the recommended practice for hand-holes.

The Secretary has also announced the following subjects and committees for the Convention to be held in June, 1896:

1. *Metal for Brake-shoes, Laboratory Tests.*—S. P. Bush, D. L. Barnes, John W. Cloud. In making final report this Committee to confer with the Executive Committee of the Committee on Road Tests of Brake-shoes of 1895—R. H. Soule, A. E. Mitchell, W. S. Morris.

2. *Automatic Couplers.*—To advise what changes may be desirable in the standard size of Master Car-Builder automatic coupler shanks, and to recommend a standard yoke or pocket strap for rear-end attachment to cars—J. M. Wallis, R. D. Wade, T. G. Duncan, A. E. Mitchell, William Garstang, Thomas Kearsley, J. T. Chamberlain.

3. *Mounting Wheels.*—To review the subject of mounting wheels and the standard check gauge, together with the standard distance between wheels—J. N. Barr, A. M. Waitt, J. H. McConnell, R. E. Marshall, J. C. Barber, Thomas Sutherland, Pulaski Leeds.

4. *Passenger Car Ends and Platforms.*—To consider what improvements may be made in the construction of passenger car ends and platforms for increased strength in ordinary service and in emergencies—E. W. Grieves, F. D. Adams, J. J. Hennessey, C. A. Schroyer, M. M. Martin, Samuel Porcher, T. A. Bissell.

5. *Axle, Journal-box, Bearing and Wedge for Cars of* 80,000 *lbs. Capacity.*—To propose standards with detail drawings of same—E. D. Nelson, William Forsyth, J. E. Simons, J. H. Rankin, John Hodge, F. W. Chaffee, George Gibbs.

6. *Metal Underframing for Freight Cars.*—To discuss the extent to which metal may be used with economy and advantage; also the best forms—R. P. C. Sanderson, D. L. Barnes, Robert McKenna, J. D. McIlwain, Clement Hackney, John Player, J. R. Skinner.

7. *Location of Air-brake Cylinders on Freight Cars.*—Having in view easy access for cleaning and repairing—James Macbeth, B. Haskell, A. C. Robson, Robert Gunn, F. B. Griffith, Joel West, H. C. McCarthy.

8. *Freight Car Doors and Attachments.*—To inform the Association as to the latest improvements and the best practice—

F. H. Soule, B. E. Thomson, Charles Waughop, J. J. Casey, Thomas Fildes, A. J. Cromwell, W. J. Robertson.

9. *Handholds and Height of Drawbars.*—To review the recommended practice in regard to handholds and to advise whether greater uniformity can be secured in their location on cars of different types or classes, and to advise what will best conform to the requirements of the law. Also to advise what shop or repair practice will be most desirable in order to have the height of drawbars at all times in conformity with requirements of law—H. S. Hayward, Tracy Lyon, L. B. Paxson, S. A. Charpiot, J. W. Marden, S. Higgins, S. A. Crone, W. A. Nettleton, C. A. Schroyer, J. Mackenzie, A. E. Mitchell.

10. *Uncoupling Arrangements for Master Car-Builders' Automatic Couplers.*—To consider whether a standard uncoupling device is practicable and the details thereof—G. L. Potter, Samuel Irvin, G. W. West, C. E. Turner, R. M. Galbraith, G. B. Sollers, R. C. Blackall.

The Institution of Civil Engineers—Mr. James Forrest, the Secretary, has issued from his office in Great George Street, Westminster, London, S.W., a circular giving the subjects and conditions regarding papers for which prizes are offered by the institution. This circular states that the Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose.

The Council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from members of the Institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors.

LIST.

1. The most economical methods of handling large masses of excavation, as exemplified in modern canal construction.
2. The measures necessary for the improvement of canal navigations.
3. The methods adopted in carrying out large dock and harbor works, with descriptions of the plant employed.
4. The appliances for dredging and for removing rock in deep water, with details of the time occupied in the various operations.
5. The application of compressed air, steam and hydraulic power to rock-drills.
6. The construction, equipment, and working of light or economical railways of a permanent character.
7. The design and construction of railway carriages, having reference to (*a*) lavatory accommodation; (*b*) provision for refreshments; and (*c*) sleeping arrangements.
8. The use of compressed air in subaqueous tunnelling.
9. The modern methods of pumping compared as to cost and efficiency.
10. The use of steel in the construction of large water-tanks.
11. The employment of storage-reservoirs in irrigation and in the conservation of rivers.
12. The purification of sewage by precipitation, filtration, electrolytic, bacteriological, and chemical processes.
13. The use of ash-bin refuse in towns for the production of steam.
14. The purification of large quantities of water after its use in manufactories.
15. The methods of enriching coal-gas and their effect on its calorific and illuminating values.
16. The production and enrichment of water gas.
17. The methods of conveying and of using natural gas.
18. The utilization of heat (*a*) generated in the compression of air and other gases; (*b*) carried away by steam engine condenser-water; and (*c*) contained in boiler-furnace flue-gases.
19. The methods of condensing steam by the use of moderate quantities of water.
20. The methods of removing moisture from steam, and of reducing losses by radiation from steam pipes.
21. The production and use of superheated steam.
22. The theory and development of the compound steam-turbine.
23. The recent development in gas-engines and oil-engines, including a comparison of the relative merits of the several cycles, with reference to "after-burning."
24. The application of oil and gas-engines to tractive purposes on common roads and on tramways, and to the propulsion of vessels.
25. The design and construction of large turbines.
26. The methods of testing the lubricating values of oils, greases, etc.
27. The comparative merits of blast and reverberatory furnaces.
28. The influence of carbon on iron.
29. The magnetic properties of iron and steel.
30. The manufacture of steel for structural purposes.
31. The strength of steel shafts, tubes, and cylinders.
32. The mining of thin seams of coal.
33. The underground arrangements in collieries.
34. The influence of coal dust in contributing to colliery explosions.
35. The efficiency of centrifugal fans for forced draft and for the ventilation of mines.
36. The drainage of mines by pumping and by tunnelling.
37. The extraction of metals from their ores by electrolytic processes.
38. Argentiferous lead smelting in water-jacketed blast-furnaces.
39. The methods of gold-mining in California.
40. The occurrence, production, and uses of (*a*) asbestos, (*b*) arsenic, and (*c*) mercury.
41. Aluminium, its manufacture, properties, uses, and alloys.
42. The metallurgy of chromium, molybdenum, and other rare metals, and their use in the manufacture of steel.
43. The design, construction, erection, and working of modern stamp mills.
44. The machines for raising mineral tailings, as lifting-wheels, pumps, dredgers, etc.
45. The most suitable steam-power equipments for electric-light stations.
46. The utilization of electric-lighting plant during hours of small demand.
47. The utilization of electrical energy in the form of heat.
48. The regulation of electric pressure in large lighting circuits as carried out at the engine, the dynamo, or the exciter.
49. The theory and practice of the transmission of power by alternating currents.
50. The use of electrical motors for driving machines in textile factories and in engineering workshops.
51. The first cost, facility, and economy of operation of electrical traction on railways with heavy trains and on tramways.
52. The construction and working of electrical lifts and cranes.
53. The electrolytic action of return currents in electrical tramways on gas and water-mains, and the best means of providing against electrical disturbances.
54. The most suitable alloys for the working parts of pumps for lifting corrosive liquids from mines, etc.
55. The methods of preventing or arresting the corrosion of hydraulic rams of large diameter.
56. The use of the die-press in workshop operations.
57. The modern rolling-mills of the United States.
58. The appliances used in the manufacture of smokeless powder.
59. The transport, storage, and manipulation of grain.
60. The different systems of refrigeration, and of appliances for the storage and preservation of food produce.
61. Brine-pumping and the manufacture of common salt.
62. The present limits of speed at sea.
63. The most recent types of (*a*) passenger and mail steamers; (*b*) cargo steamers.
64. The relative advantages of single screws, of twin screws, and of triple screws in large vessels.
65. The use of electrical machinery for lighting and the transmission of power in warships and in the mercantile marine.
66. The best position for torpedo-discharging tubes on large vessels, with a fixed direction or trainable.

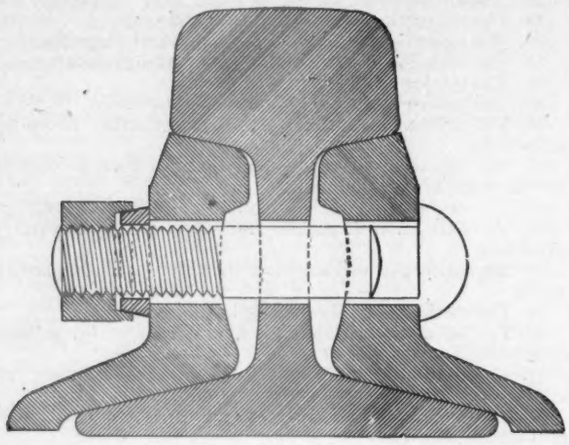
INSTRUCTIONS FOR PREPARING ORIGINAL COMMUNICATIONS.

In writing these essays the use of the first person should be avoided. They should be legibly transcribed on foolscap paper, on one side only, leaving a margin on the left side, in order that the sheets may be bound. Every paper must be prefaced by an abstract of its contents not exceeding 1,500 words in length.

Illustrations, when necessary, should be drawn on tracing-paper, to as small a scale as is consistent with distinctness, but in no case should any figure exceed 6½ in. in height. When an illustrated communication is accepted for reading, a series

of diagrams will be required, so drawn and colored as to be clearly visible at a distance of 60 ft. These diagrams will be returned.

Papers which have been read at the meetings of other societies, or have been published, will not be accepted. According to the by-laws every paper presented to the Institution is deemed to be its property, and may not be published without the consent of the Council.



SECTION OF RAIL WITH THE KLEMAN NUT-LOCK APPLIED.

The communications must be forwarded to the Secretary, from whom any further information may be obtained. There is no specified date for the delivery of manuscripts, as when a paper is not in time for one session it may be dealt with in the succeeding one.

Manufactures.

THE KLEMAN NUT-LOCK.

THE Kleman nut-lock consists of a combination nut having a countersunk cavity on its inner face, and an annular tapering divided washer fitted in the countersunk recess, the washer being made of a sufficient depth that when the nut is tightened on the bolt, the washer will project from the recess and bear against the plate or bearing.

The washer is oil-tempered and made of the best spring steel. In applying the nut-lock to use, the washer is put on the bolt against the bearing, and then the nut is screwed home upon the plate until its countersunk cavity encircles the washer. Further tightening the nut will compress the washer which is around the bolt, and will press against the bearing applied and cause the nut to lock on the washer, as will be readily understood by reference to the cuts.

The nut itself does not bear against the bearings or plate applied, as the outer face of the washer does not extend to the base of the cavity. In the nut space is allowed for expansion and contraction of the bolt.

The bearing against the plate is taken entirely by the washer, and as this is divided it will yield so as to fit easily against the plate, and afford a perfect bearing, even though the plate be irregular in shape, whereas if the nut should be allowed to bear against the plate such evenness of bearing is not always attainable.

This nut-lock has been thoroughly tested in various ways, when it has been subject to vibration and is reported to have shown its excellence and superiority.

The bolt from which our engraving was made came to us with a wooden block between the head and nut, the surface of the block being somewhat beveled, to show that the washer will take a bearing on such a surface as well as it will on one which is square with the axis of the bolt. The block was omitted in our illustration to show the form of the washer and the cavity in the underside of the nut.

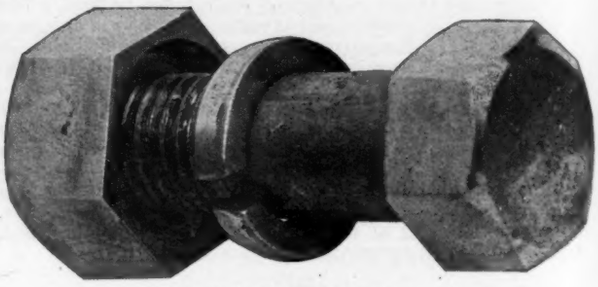
The Allison Manufacturing Company, of Philadelphia, have undertaken its manufacture, and are prepared to fill orders of any magnitude.

THE DAYTON GAS ENGINE.

THE gas-engine illustrated in this connection is one that is being made by the Dayton Gas-Engine Manufacturing Company, of Dayton, O. In general appearance it is very similar to those of other makes, the difference lying in the adaptation of fundamental principles. An arrangement that will strike the eye of the observer at once is that the working parts, such as the valves, etc., are clustered on the top of the cylinder, instead of being placed on one side or attached to the cylinder head. The valves are of the poppet type, and each valve is worked positively and directly from the cam-shaft by means of a separate stem that has double bearings, keeping it in perfect alignment.

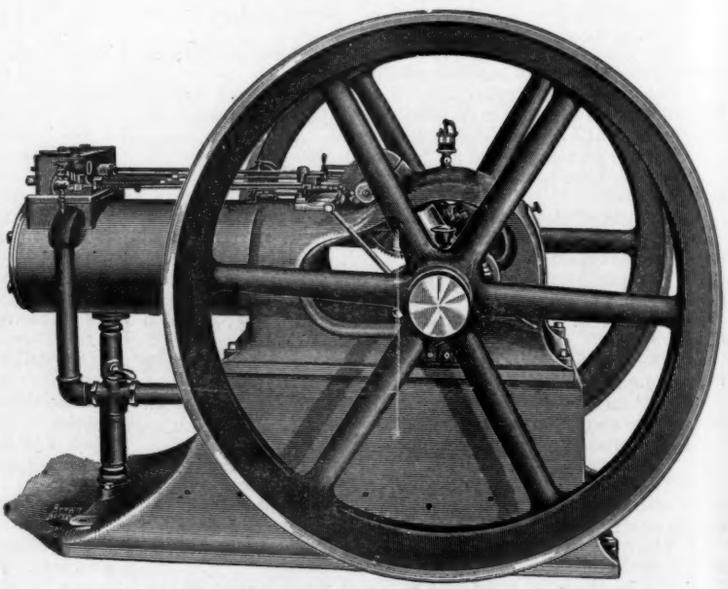
No carbureter or vaporizer is used, but the gasoline is taken directly from the tank, which is lower than the inlet. This is done without the use of intricate pumps or other devices that could tend to complicate the working of the engine.

The engine is also provided with a covered crank-shaft, as shown in the engraving, and surrounding objects are thus protected from oil that may be thrown from the bearings, while the engine itself is protected from an accumulation of dirt and grit.



THE KLEMAN NUT-LOCK.

The mixture of air and gas is fully accomplished before they enter the cylinder, and the cylinder and the explosion-box are both water-jacketed without having any packing whatever between the former and the water chamber. The chief feature of the engine is that it is built upon the principle of regulating by governing the explosive mixture rather than by governing the frequency of the explosions. It thus becomes possible to regulate the speed of the engine, so that in case it is desired to throw a belt on or off from the engine-pulley, or do any similar work, the speed of the engine can be reduced almost to stopping, and the engine speeded up again without



THE DAYTON GAS-ENGINE.

actually coming to a stop. It is also arranged so that the speed can be increased or decreased at will while running, when it will continue to run at the new speed until a further change in the adjustment is made.

Either gas or gasoline can be used in the engine, and with the same apparatus; indeed, it is possible to shut off the supply of one kind of fuel and turn on the other while the engine is in motion. In regard to consumption, it is said to be from 16 to 20 ft. of natural gas per H.P. per hour, or three-fifths of a pint of gasoline.

In testing these engines they are not bolted or in any way fastened to the floor, and the full load is suddenly thrown on and off with no difference in the working, except in the variation in the number and intensity of the explosions. The engine is ordinarily built for electric ignition, but can be changed to tube ignition.

IMPROVED AUTOMATIC HOLLOW CHISEL MORTISING AND BORING MACHINE.

THE machine here illustrated, which is made by J. A. Fay & Co., of Cincinnati, O., is intended for mortising all kinds of heavy timbers used in car and bridge construction of all classes, either in hard or soft woods. It is a powerful and compact machine, is automatic in its operation, and works with great rapidity. When once set, and the machine started, it will make any number of mortises without change.

It is operated by the reciprocation of a square hollow chisel having an auger revolving in its centre, the chisel squaring the hole produced by the auger. The superiority of this method of mortising is apparent from the fact that the mortise is left in a completed condition, no cleaning out being required, and a mortise of any length can be made by continuously cutting one hole after another on the same line. The reciprocation of the chisel is automatic, and the work produced very rapidly by the ease with which the movements and adjustments can be made by the operator.

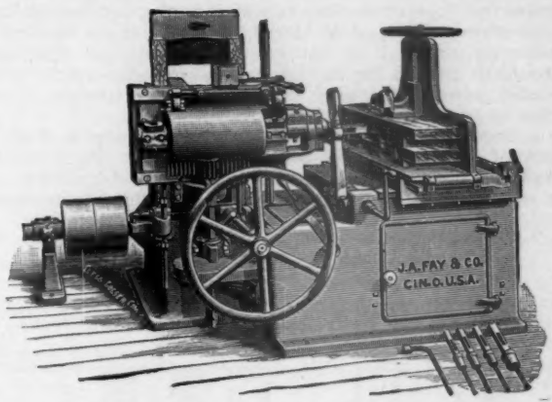
The bed supporting the timbers is massive, and capable of enduring the strain it is subjected to in heavy work. It has adjustments for carrying it to and from the chisel for different thicknesses of material and depths of mortises. It remains at one height, and is movable endwise to produce the varying lengths of mortises. There is a clamping arrangement for holding material in position, stops for gauging the lengths of mortises, and for using templates in producing duplicate mortises.

The chisel frame and auger spindle are carried on a heavy vertical column which is connected to the base on which the bed for the timber is placed. It has a vertical movement on the column to allow the position of the chisel to be varied up or down according to the desired position of the mortise. There are stops to regulate the height of the travel of the chisel frame, which is moved by means of the large hand-wheel, and has a device for locking firmly at the height of the mortise, and easily moved up and down for double mortising.

The reciprocating motion of the chisel frame is produced by a reversing friction and gearing which operates in a rack on the chisel frame, the driving force coming very near the point of resistance of the chisel. The reversing friction is operated by a trip on the chisel frame support, moved by dogs on the chisel frame, which are adjustable for varying distance of travel of the chisel.

The countershaft is attached to the machine, driving the reversing friction by two belts, and a belt to the auger spindle over a pair of idlers, one of which automatically adjusts to the varying lengths of the belt as the chisel is raised and lowered.

The machine can be used for single and double mortising for gaining, countersinking, end tenoning, and boxing. The chisel has a travel of 10 in. in depth, and the vertical range of work is 13 in. Mortises can be made to 2½ in. square. The



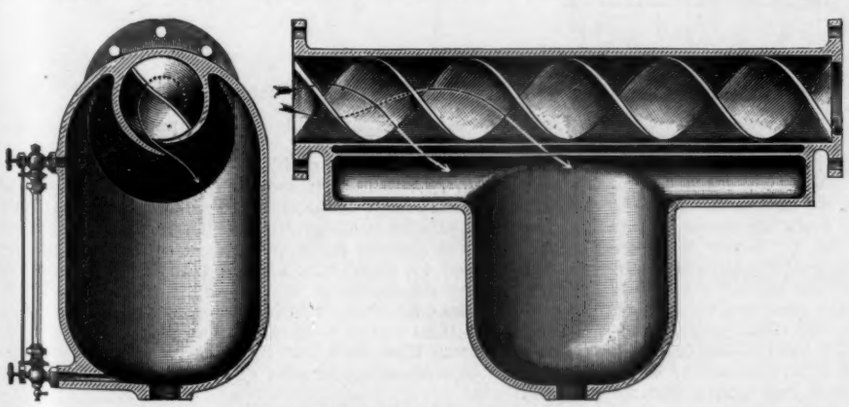
AUTOMATIC HOLLOW CHISEL MORTISING AND BORING MACHINE.

table will receive material 15½ in. high. An auxiliary boring attachment can be added to the machine if desired. The machine is furnished with ¾-in., ⅞ in., 1-in., 1¼-in., and 1½-in. chisels and augers. A shop number is attached to each machine, reference to which in correspondence will identify the class of the machine and the style of its construction.

The tight and loose pulleys are 12 in. × 6 in., and should make 1,000 revolutions.

THE MOSHER STEAM SEPARATOR.

ALL experimenters with steam are well aware of the difficulty or, it may be said, of the almost impossibility of separating water from steam by gravity, whether it came there by entraining or condensation, as it has been found that a current of steam having a velocity of 3 ft. per second is amply sufficient to sustain and carry away a quantity of water. The separator that is herewith illustrated is one that has been designed by Mr. C. D. Mosher, of No. 1 Broadway, New York, in which he uses a centrifugal action to throw the water out of the steam, allowing the latter to pass on to the engine in a dry condition. It will be seen from the longitudinal and cross-sections that are given in the engravings, that the separator consists of a slightly enlarged section of the steam-pipe that is made of a spiral-shaped cross-section, and contains a worm running from end to end, this worm being so twisted that the course of the steam as it passes through it is given a whirling motion, and this whirl is such that it runs against the lip that is formed on the under side by the spiral. As the water is heavier than the steam, it is thrown out against the side of the separator and shaved off, as it were, by the lip, whence it may pass into the drum that is shown below, or into the boiler itself when the separator is placed in the dry-pipe, while there is practically but little increase of resistance to the flow of the steam.



THE MOSHER STEAM SEPARATOR.

This style of separator is also particularly well adapted to the separation of oil from exhaust steam, and thus preventing the clogging of pipes when it is used for heating purposes and also the corrosion of metallic roofs upon which it would otherwise fall. It is built in sizes ranging in diameter from 1½ in. to 12 in., for the size of the steam-pipe, and is thus upon the market to meet all ordinary requirements.

Recent Patents.

RAILWAY CAR.

MR. HENRY PEARSON, Superintendent of the Wason Car Company, near Springfield, Mass., has patented a method of framing passenger cars which seems to have much merit. The invention is primarily intended for what are known as "drop bottom" cars, or, in Southern vernacular, as "possum belly" cars, in which there is an extension of the car body or its sides below the floor of the car, in which berths, bedding or baggage may be disposed or stored, or which might be used for other purposes. It is not essential, either, that this space should be utilized for any purpose, as the sides might be extended downward merely to secure greater strength in the truss or frame of the car body.

In the illustration fig. 1 is a side view of a car having the form of construction proposed by Mr. Pearson. Fig. 2 is a side view of a portion of the car body in an enlarged scale. Fig. 3 is an inverted plane showing the parts of fig. 2 immediately above fig. 3. Fig. 4 is a vertical longitudinal section through the side sills at and along one side of the frame of the car body. Fig. 5 is a vertical cross section on the line 5 5 of fig. 4.

Fig. 1.

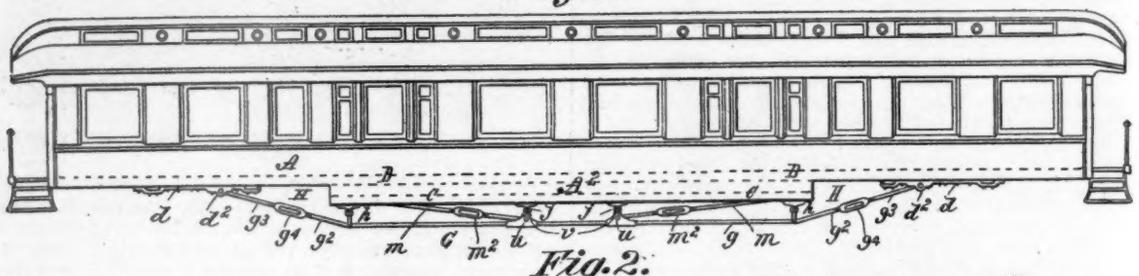


Fig. 2.

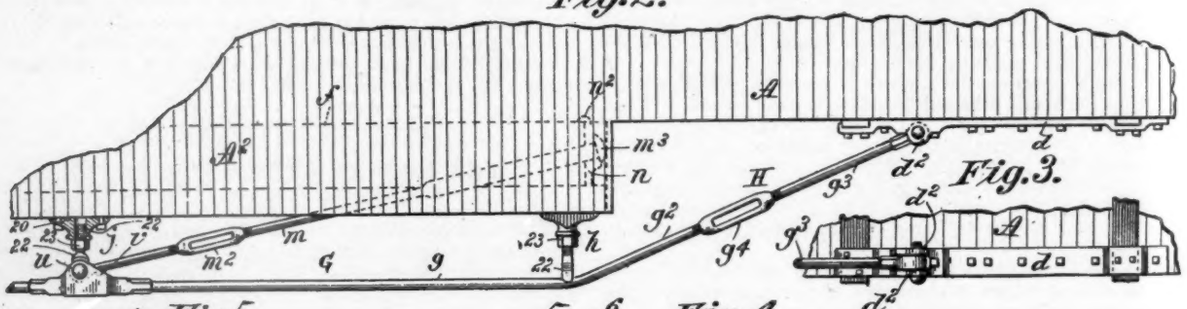


Fig. 3.

Fig. 5.

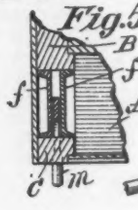
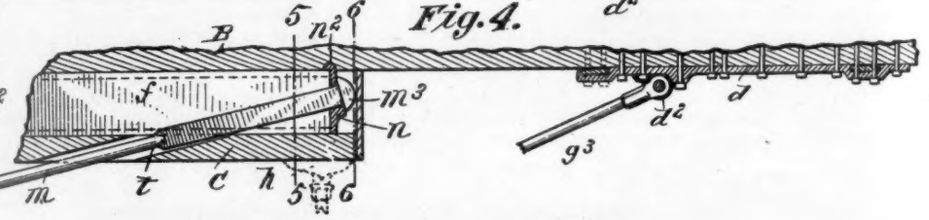


Fig. 4.



From fig. 1 it will be seen that the car body *A* has an extension or "possum belly," A^2, between its ends, and below the floor or bottom of the car. The car body has the usual side sills *B B*, shown by dotted lines in fig. 1. Below these are sub-sills *C C*, extending the whole length of the depressed portion A^2. Between the main sill *B* and the sub-sill *C* a pair of channel irons, *f f*—shown clearly in the sectional views, figs. 4 and 5—are placed. These form the top chord of the intermediate or secondary truss *H v H*, fig. 1, the purpose of which is to strengthen or support the central part of the car body. This truss consists of the rods *m v m* and queen-posts or struts *j j*. The method of attaching the rods to the channel bars is clearly shown in fig. 4.

The main truss d^3 *G G* d^3 is of the usual form, excepting that the rod *T T* has lugs *u u* forged on it, to which the rods *m m* are attached. This construction, and also that of the main queen-posts *h h*, are clearly shown in fig. 2. The main sill *B B* forms the top chord of the main truss, as in the ordinary method of construction; the downward extension, however, gives it more depth than such trusses usually have in passenger cars. This form of construction would therefore appear to increase the strength of a car very materially. The date of the patent is July 23, and the number is 543,050.

RAILWAY SIGNAL POST.

Figs. 6 and 7 represent an ingenious design for signal posts patented by Mr. Sherburn Sanborn, of Chicago, the construction of which he describes as follows in his patent:

"I take two bars of iron, *B*, provided with heads *b* and bases *b'*, connected by webs b^3, and of the desired length to give the requisite height desired in the post. These bars are placed base to base and fastened together by bolts or rivets, as shown in the drawings, for a portion of their length. The bars above the point where their bases are riveted or fastened together are spread apart so as to afford a space, *C* (fig. 6) between the bases. This space affords room for mounting the operative parts of the signal in place between the bases of the bars, which are wide or broad enough to sufficiently house and protect them. The post, when thus completed, is intended to be securely set or planted in the ground to occupy a vertical position and elevate the signal-lights and other parts to the required height.

"By employing bars provided with heads and bases, as shown in fig. 7, which is a transverse section on the line 2 2 of fig. 6, sufficient base is secured to enable the post to be firmly and securely planted in the ground, while the diminished thickness of the web permits earth and gravel to be firmly and securely packed in, about, and around the post to prevent its ready or easy displacement, and the spreading of the upper portions of the bars apart furnishes less resistance to the action of the wind than where large and solid posts are employed, and at the same time sufficient room is secured for the location, arrangement, and operation of the working parts of the signal."

Obviously old and worn rails could be used for making these signal posts. The patent is dated August 6, and numbered 544,008.

STEAM BOILER.

Messrs. William Sellers, of Philadelphia, George S. Strong, of New York, and Henry B. Bradford, of Wilmington, Del., are the inventors of a steam boiler (figs. 8 and 9) which is described in their patent, No. 544,130, dated August 6, and which

they have assigned to the Edge Moor Iron Company. The objects of their invention are set forth as follows in their patent:

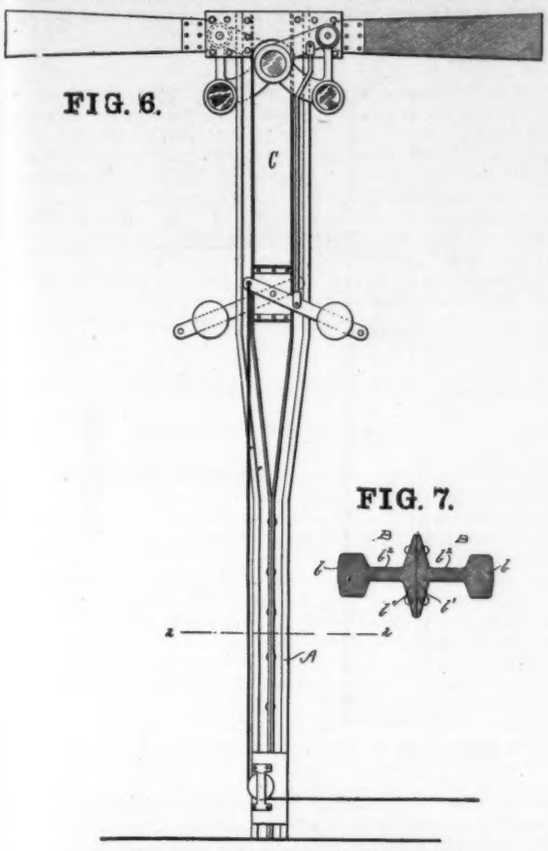


FIG. 6.

FIG. 7.

SANBORN'S RAILWAY SIGNAL POST.

"The improvements relate to that class of cylindrical steam boilers known as 'internally fired return tubular.'

"This form of boiler is usually provided with two furnaces and a manhole between and below them for access to the interior of the boiler shell and an uptake within the boiler near the rear end, into which the products of combustion from the furnaces are discharged, and from which they are carried through tubes above the furnaces to a smoke flue at the front of the boiler and above its fire doors to the chimney. With this construction the greatest heat of combustion is far below the surface of the water, so that the evolution of steam produces foaming when the work of the boiler is pushed to its maximum. Moreover, the smoke-flue being above the firing-doors compels the discharge of the products of combustion upward, whereby the light cinders and ashes must be carried forward with the current of heated gases without opportunity to separate otherwise than as a deposit in the flues or tubes, while ashes accumulate in the uptake, which cannot be removed while the boiler is in service.

"One object of our improvement, therefore, is to apply the greatest heat as near as possible to the surface of the water and at the same time to render the interior of the boiler accessible throughout its length, also to avail of the greater specific gravity of the cinders and ashes and to separate them from the gaseous products of combustion whenever the downward direction of the currents of gaseous products is changed.

"Another is to carry off the products of combustion to the chimney along the under side of the boiler and at the same time provide for the expansion and contraction of the boiler without affecting its setting.

"Another is to provide a support for that end of the boiler which is movable upon its setting, which shall automatically adjust itself to produce a uniform pressure thereon.

"Another is to provide for removing the solid products of combustion from the tubes without removing from the boiler any part of the covering of its smoke-flues; and another is to provide a descending smoke-flue on the front head of the boiler outside of and between and below the fire-door frames, which flue forms an extension of the ash-pits under the furnaces.

"The invention consists of two or more furnaces with combustion chambers, which respectively connect the front and back heads of the boiler and open through both, a smoke flue outside the back head, and return tubes secured in both heads between and below the tops of the furnaces and combustion chambers.

"It further consists in downward smoke-flues with cleansable receptacles below their outlets for the products of combustion; in a series of horizontal tubes arranged in vertical lines and a hinge-jointed cover secured upon the front smoke-flue, the joint in this cover in a plane that will pass between the vertical lines of the tubes; in a smoke-flue, the top of which is the boiler, from which the two sides and one end of the flue are suspended and penetrate a sand-joint on the bottom to a depth that will practically exclude the air; and in two fixed supports at one end of a boiler and two roller supports at the other, the weight at the roller end transmitted to the roller supports respectively through a ball and socket, and it further consists in a descending smoke-flue on the front boiler-head, which flue is outside of and between and below the fire-door frames and forms an extension of the ash-pits under the furnaces."

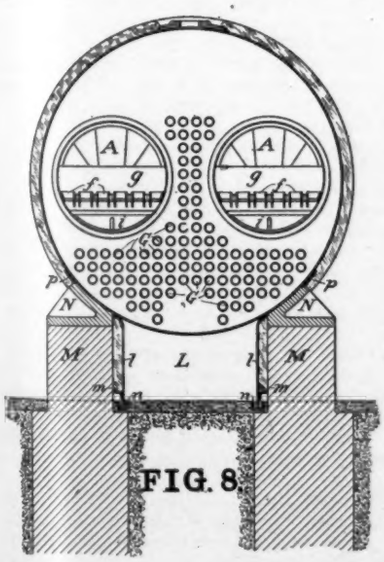


FIG. 8.

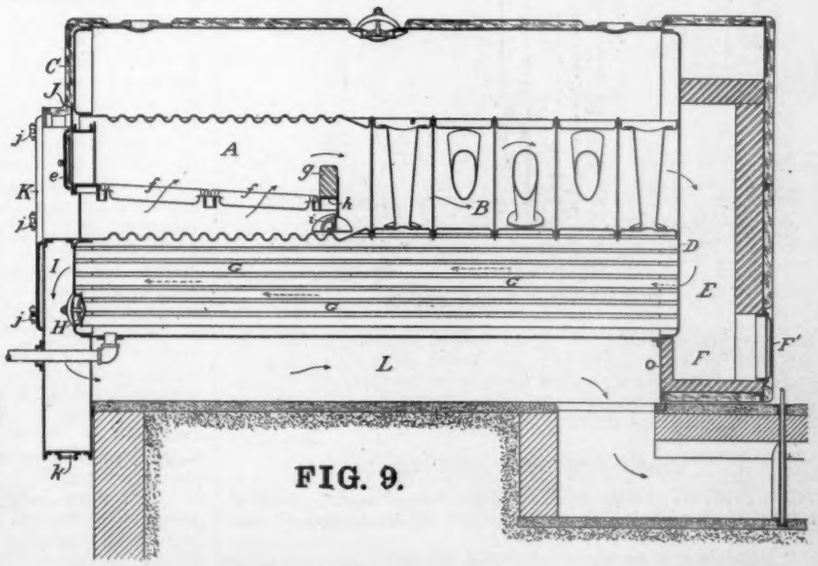


FIG. 9.

THE STRONG STEAM BOILER.

A lengthy description follows this statement of the objects of the invention.

CAR TRUCK.

Mr. Albert K. Mansfield, of Salem, O., is the inventor of the truck shown by figs. 10, 11 and 12, and described in patent No.

545,409, dated August 27, of which he has assigned one-half to Samuel M. Felton, of Cincinnati.

One of the principal objects aimed at in this design is to use ordinary shapes of I beams, channel bars and plates in its construction, which are a common article of merchandise in the open market, and which can therefore be obtained at lower cost than special forms could be.

The side frames 1 of the truck shown consist of I beams with openings or "jaws" cut into their lower sides to receive the boxes 2 2. These openings are then reinforced by angle bars 3 bent into the form of an inverted letter ∩, and which are riveted to the web of the I beam as shown. The lower portion of the jaws are then held together by pedestal braces 4 bolted to the lower flanges of the I beam 1. Fig. 11 is a transverse section through the transoms and fig. 12 is a horizontal section on the line *x x*.

The transoms consist of channel bars 10 10, which are fastened to the side frames by angles 11 11, to which they are riveted. These channel bars are braced on their under side by diagonal braces 12 12, which hold them in position and keep the truck square. The bolsters consist of a pair of I beams, a sectional view of which is shown in fig. 11. The springs are supported by plates 15, which are bent into U shape and are riveted to the channel bars. The design seems to be an excellent one, and as only ordinary standard shapes are used in its

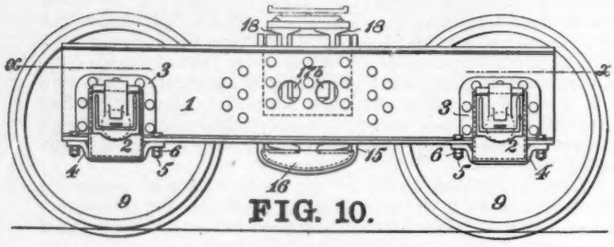


FIG. 10.

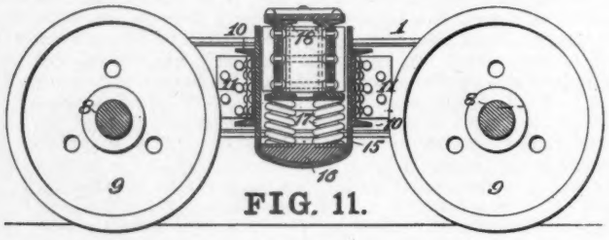


FIG. 11.

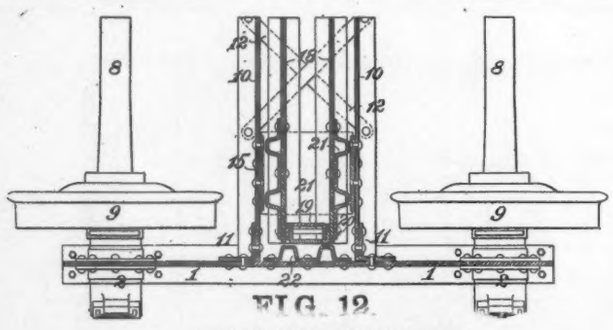


FIG. 12.

THE MANSFIELD CAR TRUCK.

construction, and as little or no special machinery would be required for the manufacture, this truck should have the advantage of cheapness; and if the cost is lessened and the endurance lengthened there it will have the happy collocation of merits which all are striving to obtain.

ILLUMINATED SEMAPHORE SIGNAL.

Mr. Jacob W. Lattig, of West Bethlehem, Pa., has patented a form of illuminated semaphore arm, shown in figs. 13 and 14, which he describes as follows:

"Extending along the longitudinal centre of the semaphore arm is a row of incandescent electric lamps, *h*. These lamps are secured by their sockets to the semaphore arm, and are placed preferably at intervals apart of a foot throughout the length of the blade.

"The lamp terminals on one side are connected to a wire, 1, common to all. On the other side each lamp terminal has its individual wire leading and connected to a stationary brush pertaining to that lamp terminal alone, there being as many brushes (numbered 2 to 7, inclusive) as there are lamps. These brushes are arranged as the stationary contacts of a commutator around a rapidly rotating contact or trailer, 8, which meets the brushes successively, preferably making contact with the one in advance just before it quits the one next in rear, to

FIG 13

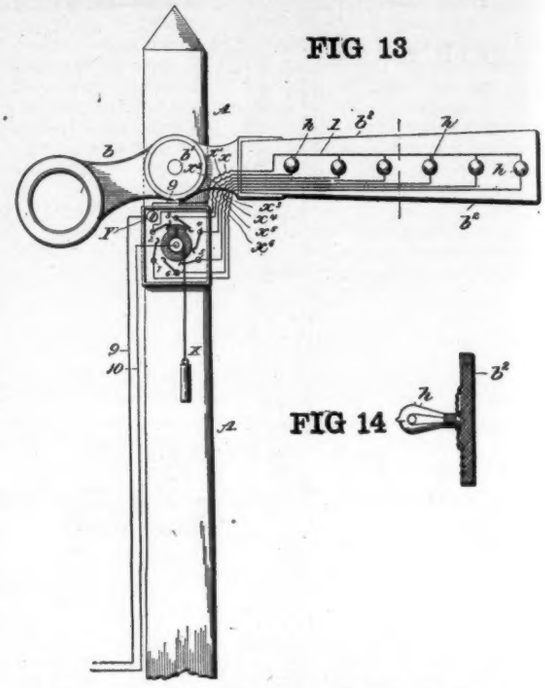


FIG 14

THE LATTIG ILLUMINATED SEMAPHORE SIGNAL.

prevent arcing at contacts. The rotating contact is intended to revolve continuously when in action, being driven for this purpose by any suitable motor, electrical or otherwise. Where direct currents are employed, I prefer an electrical motor to run the commutator. Where alternating currents are employed, I prefer a mechanically operated commutator, the mechanical motor in the present instance being clock-work typified by the cord and weight *X*. The wire 1, by a flexible cable, *x*, is connected to the wire 9 on the post leading to one pole of the source of electrical supply, the other pole of which is connected to the revolving commutator contact disk 8 by wire 10. There is a similar flexible connection, $x' x^2$, etc., between the individual lamp terminal wires and their respective stationary contact springs or brushes 2, 3, etc. The flexible connections $x\ x'\ x^3$, etc., are for the purpose of permitting the free movement of the semaphore arm on its pivot. A switch, *Y*, is provided to make and break the circuit, as desired. When the circuit is closed at *Y* and the commutator in action, the lamps will successively be brought into circuit, one during each revolution of the commutator disk. The effect upon the eye of the observer, owing to the rapid rate of the movement of the trailer 8, will be a streak of light running from end to end of the semaphore blade intermittently, no matter what may be the position of the arm, whether inclined or straight. The light may be white, red, green, or any other color desired.

"The arrangement, while producing the impression of a continuously moving streak of light, economizes current materially, as the quantity of current consumed will not exceed materially, if at all, that required to maintain a single constant light. A light may be placed behind the spectacle glass in the casting *b*, if desired, and this light may be made to take its turn along with the rest by providing suitable commutator connections for it.

"Under my improvements the same line of lights are exposed to the train at all times, and those lights are not continuous, but intermittent. Not only is there economy in this last feature, but also a new effect is produced in railway signalling. The rapid running intermittent streak of light produced by the rapid movement of the trailer contact makes a very much more distinctive signal and will more readily attract the attention of the engineer. The signal becomes in effect an automatic flagman, to stop or start a train by movements similar to those employed by the flagman with his lantern or flag for the same purpose."

The patent is dated September 3, and numbered 545,071.

AERONAUTICS.

NOTICE.

In our issue of last October it was announced that thereafter AERONAUTICS would be made "a supplementary subject in THE AMERICAN ENGINEER," and "that under that heading it was intended to give the most reliable information relating to the science and art of aerostation." Since that time a separate department, occupying from four to six pages, has been devoted to that subject. Owing to insufficient patronage, this department will be discontinued after this issue of THE AMERICAN ENGINEER. Hereafter important events, which indicate that real progress has been made in the art or science of aeronautics, will be chronicled, but it will be published with other matter, and not in a separate department.

AEROPLANE STABILITY DURING FLIGHT.

By WILLIAM KRESS, VIENNA.

THE simplest form of aeroplane construction, used by myself since 1879, consisted of a main concave carrying surface at the front and of a large flat surface, or tail, at the rear, forming thus two horizontal carrying surfaces, as far apart as practicable, between which were located two elastic sail air screws or propellers, either side by side, or one behind the other, and rotating in opposite directions. Under the tail or horizontal rudder, and as far to the rear as possible, was located a vertical rudder. A fish-bellied car was suspended below, and mounted on sled-runners in such a way that the apparatus, when on the ground, should present a small upward angle of incidence to the air, the main aeroplane being, however, attached horizontally, or parallel to the axis of the air-screws; the inclination of the machine, upward or downward, during flight being produced by changing the position of the horizontal rudder, or being due to a change in the velocity of the whole apparatus.

Hence, the position of the main front surface, and also the centre of gravity of the machine, are left unchanged as much as possible, and are not moved about by any mechanical contrivance. It is a mistake, into which many aviators have fallen, to suppose that an aeroplane can only be kept in equilibrium during flight by a mechanical adjustment of its centre of gravity or of the centre of pressure of its wing surface, or by changing the angle of incidence of its wing surfaces. Marine navigation would be quite impossible if a ship could not maintain its equilibrium automatically on the waves, but was dependent for its safety upon the skilful manipulations of some mechanism by the steersman.

In order, however, to give the aeroplane as great a stability as possible, and to make it as little sensitive as may be against any accidental changes in the centre of gravity, I now separate my horizontal carrying surface into two or more surfaces of about equal size.

It is true that a single carrying surface, with the addition of a small horizontal rudder, attached immediately behind the main wing (so that the centre of oscillation coincides very nearly with the centre of pressure), has been used by an aviator of high standing, in an apparatus widely advertised of late throughout the world; but this apparatus, at least in its present shape, requires the skill of an acrobat for its manipulation, and exposes the aviator to such risks that it cannot be accepted as a solution of the problem.

I consider it as a prime requisite in any flying apparatus that it shall have at least two distinct points of support, and that the centre of gravity shall be between the two, in a position as fixed and immovable as possible.

In the course of my experiments I have often placed a small weight in the car of my model, sometimes in the front and then again in the rear, without destroying the equilibrium or producing a marked oscillation of the apparatus in flight. This proves sufficiently that passengers will be able to move about in the car of a properly designed aeroplane machine, and to change places pretty freely without materially disturbing the balance of the apparatus.

I have lately built and tested in flight a model (fig. 1) with three horizontal surfaces, B^2, B^1, and C of the illustration herewith.

The addition consists in the head wing B^2, and although this second model maintains its equilibrium very well, I have become convinced that the head wing B^2 was placed too close to the main wing B^1, and that the horizontal rudder C was too small. The use of three carrying surfaces presents the disadvantage that the main point of support is too close to the centre of gravity. It is clear, however, that the larger the number of aeroplane surfaces in an apparatus, at proper distances, the greater will be its stability, and I have designed a further improvement in which I have used four carrying surfaces.

In the case of several wing surfaces, thus arranged one behind the other, they must be separated by at least the width of a wing, and each wing must be slightly lower than the wing in front of it. They must all be attached parallel to the propeller axis—that is, at an angle of 0°, as shown in fig. 2.

The centre of gravity of the whole apparatus must always be well toward the front, and when the machine is not in motion, the centre of gravity must never coincide with the centre of pressure on the wing surface. As the centre of pressure is variable, and tends to move forward when the velocity of the apparatus increases, the position of the centre of gravity must be arranged, in designing the apparatus, for

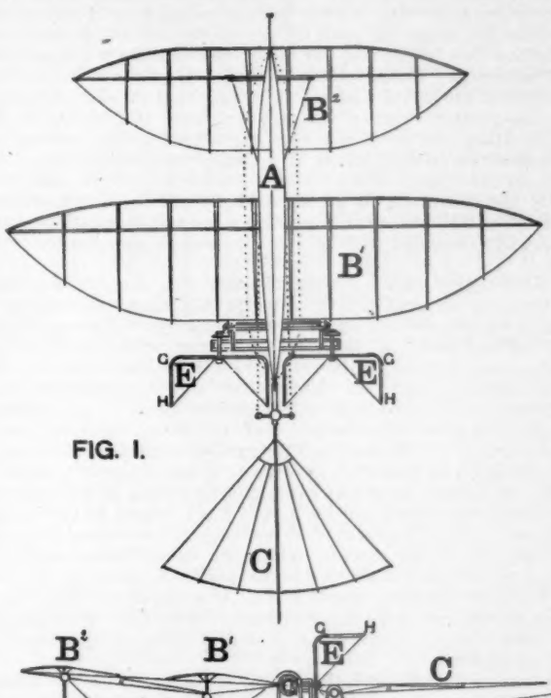


FIG. 1.

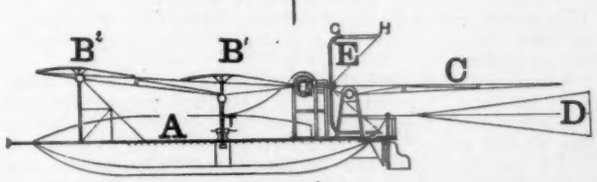


FIG. 2.

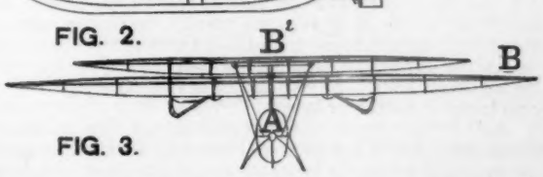


FIG. 3.

an average speed of motion. As the centre of gravity under variations of speed will never have quite the same relative position to the centre of pressure, there will be produced oscillations of the apparatus, but these oscillations will be gentle and harmless, and can easily be checked by the horizontal rudder C.

In any case it is not advisable, during flight, to change the position of the centre of gravity or the inclination of the main wing surfaces. Any desired upward or downward direction can be obtained in the best and safest manner by means of the horizontal rudder.

Before attacking the more important question—viz., *How does the aeroplane maintain its equilibrium in changing velocities of the wind—i.e., during wind gusts?* let us first consider the flight of the machine in calm air, or in a steady current of wind.

In a perfect calm rising up from the ground is most difficult, and in such a case the aeroplane must be put under way in a suitable open field or on the water, until it acquires a horizontal velocity of some 8 or 10 metres per second, or 18 to

22 miles per hour. Only after it has acquired this speed can it be steered upward by means of the rudder *c*, so as to rise upon the air as upon an inclined plane.

Let us now assume that the aeroplane has acquired, through its motor, a proper elevation and a velocity of 15 metres per second (33 miles an hour), and that the horizontal rudder is so adjusted that, at this velocity, the apparatus maintains an exactly horizontal course.

If we now change the inclination of the horizontal rudder *C* a trifle, the aeroplane will at once leave its horizontal path and move upon a new course, inclined to the horizontal, either upward or downward, according to the set of the rudder. If the motion be upward, the speed will, of course, be retarded. If the course be downward, there will be an acceleration of velocity. The same result would ensue, without change in the position of the rudder, by a variation in the speed of the aeroplane, or again by a simple displacement of the centre of gravity toward the front or toward the rear.

In all the three cases the aeroplane would no longer move in a rectilinear path, but pursue an undulatory course, alternately rising and falling. For suppose, for instance, that the aeroplane is moving with a normal velocity of 15 metres per second (33 miles an hour) in a straight horizontal path, and suppose that by forcing the motor the velocity is increased to 20 metres per second (44 miles an hour), without in any way changing the position of the rudder *C*, what will then happen?

The greater velocity not only produces an increase in the supporting power of the carrying surfaces and thus causes the machine to rise, but it also causes the centre of air pressure on the wing surfaces to move toward the front, and thus tilts the aeroplane in an upward direction. The increased "head wind" will then meet with a greater inclination of the wing surfaces, and will tend to cause the apparatus to "rear up."

Fortunately two important factors then come into action, which will automatically counteract this dangerous tendency. From the very instant at which the apparatus begins to assume an inclined position, the centre of gravity, which is below the supporting surface, will move forward by oscillation; at the same time the increased "head wind" and the greater vertical projection of the machine will *retard* the speed of the forward motion, thus causing the centre of air pressure to move backward again. This combined forward movement of the centre of gravity, and backward movement of the centre of pressure, will, of course, force the aeroplane to return to its original horizontal position. As soon as it has resumed its horizontal course, if the motor continues working at its increased speed, the velocity of the machine will again be accelerated, and the series of movements above described will be repeated.

We may therefore conclude that if a velocity greater than that corresponding to the position of its rudder *c* is imparted to the aeroplane, it will move in an undulatory line, gradually rising upward.

If, on the other hand, the reverse takes place, and the speed falls off from 15 metres to, say, 10 metres per second, precisely the same sequence of motions will take place, but in the reverse order. The centre of pressure will move backward, the apparatus will tilt downward to the front, thus causing the centre of gravity to move toward the rear, the velocity will be accelerated, and the increased pressure will then tilt the aeroplane back into a horizontal position, thus bringing about a series of oscillatory movements, and a wavy course inclined downwards.

It will depend upon the construction of the aeroplane, whether these waves are short and steep, or long and gradual. If the carrying surface is concentrated and is close to the centre of gravity, the waves and oscillations will be steep and dangerous; but if we use several distinct carrying surfaces, the wave action will be gradual and hardly perceptible.

That an aeroplane, moving in calm air, actually behaves in the manner above described, is proven by my experiments with models constructed by myself, which have been frequently exhibited in public during many years.

As my models are necessarily left to themselves during flight, the rudder *c* must be set at a definite angle for each trial, so that it is practicable to observe exactly in each experiment, from the amount of wavy motion, how closely the velocity and the set of the rudder may agree.

During Professor Boltzmann's lecture at the Naturalists' Convention in Vienna, in September, 1894, I succeeded in making my model fly, in an almost entirely level path, over the heads of the learned audience, into a proscenium box opposite.

If we now pass to the consideration of flight in a current of air, moving with uniform velocity, it will prove that the starting, the alighting, and the rate of motion relative to the earth, will be quite different from what the same operations are in a calm; but when the aeroplane has left the ground, and is immersed in the air, so that it has no physical connection with the earth, then its stability will be exactly the same as in calm air. It will be under the influence of no wind pressure, save that of the "head wind" produced by its own forward motion.

If we assume that the uniform wind current has a velocity of 10 metres per second (22 miles an hour), the starting of the aeroplane from the ground will be very easily accomplished. It will not need any preliminary run. It will suffice to dispose the apparatus with its head to the wind, to start the air-screws *E*, and to set the horizontal rudder *c* at the proper angle, in order to rise directly upward. If the aeroplane have a velocity of its own of 10 metres per second, against a wind of the same velocity, it will not possess *any* horizontal motion relatively to the earth, but will rise vertically upward. If the aeroplane be then propelled by its motor at its normal velocity of 15 metres per second, *against* a wind blowing 10 metres per second, it would move at a speed of 5 metres per second relatively to the earth. If moving *with* the wind, its speed relative to the soil would be $10 + 15 = 25$ metres per second. If, again, the air-ship have a lateral motion, say at right angles to the direction of the wind, the resulting movement would be deduced by the parallelogram of forces.

In all these cases the "head wind" acting against the aeroplane will always be simply one of 15 metres per second.

If, therefore, the aeroplane moves in a wind current blowing uniformly, it will be under exactly the same conditions as if it were sailing in calm air. The stream of air acts as that which we think of as "wind," only in relation to the earth or to a body anchored to the earth, but not so for a body immersed in the air, resting on and carried by it. A stream of air of this kind has no influence on a flying body, except in so far as it influences its movement relatively to the earth.

It must be remarked, however, that we do not meet with uniform currents of air close to the earth, and that in every case the velocity of the wind, and in many cases the direction also, changes at every instant. This may be tested in strong winds both by touch and sound, and Professor Langley has further demonstrated the fact with his measuring apparatus. Our air-ships must therefore deal with varying air gusts and waves, which render the situation a different one as regards the functions of a flying machine and its construction.

These variations in the velocity of the wind have, or rather may have, a very great influence on flying machines.

If properly utilized, they actually offer a source of power which enables soaring birds to fly through space without wing beat, and almost without any expenditure of work.

The variations in the velocity of the wind, on the other hand, may prove to be the source of great dangers to our future air-ships, as they may make more difficult the maintenance of the equilibrium, which is one of the most important requirements in aerial navigation.

I will now endeavor to prove that my aeroplane will automatically maintain its equilibrium, without any moving mechanical contrivance, notwithstanding the influence of wind gusts.

Let us again assume a normal speed of 15 metres per second for the aeroplane, and let us assign an average velocity of 10 metres per second to the wind, which, however, constantly is to vary between 15 and 5 metres per second; rising to 15 metres and instantly dropping to 5 metres per second, and so on.

If we now suppose the machine to move against the wind, just when the latter is beginning to increase its velocity, the increasing "head wind" will place the aeroplane under exactly the same conditions as those above described for a calm, or when the speed of the ship itself was increased without changing the velocity of the wind. In both cases the "head wind" will increase. In the former case there was an increase in the head resistance in consequence of the greater speed of the air-ship; in the present case this results from the greater speed of the wind. The centre of pressure will again, as in the former example, move forward, and the machine will be tilted upward and move in an upward direction. At the same time the forces tending to counteract this motion come into play; the centre of gravity moves toward the front as a result of the upward motion and increased head resistance, a retardation of the velocity and a retrogression of the centre of pressure takes place, etc.; in short, the apparatus will be forced back into its original position, exactly as is the case for motion in a calm. The path will again be a wavy line upward.

There is this difference, however, that while in a calm the motor was obliged to do an extra amount of work in order to raise the machine higher, in this last case the air-ship is lifted up without any extra work being done by the motor. The

result comes from an external cause, from the difference in wind velocity, or from the "internal work of the wind," as Professor Langley calls it.

It is true, however, that the machine, when it has been lifted up, has lost 5 metres per second of its velocity with reference to the earth, but not with reference to the surrounding air; for the amount of velocity lost by the apparatus by the upward flight is exactly made up by the accelerating effect of the wind, so that the machine reaches the higher level with its original velocity of 15 metres per second as regards the air surrounding it. Seen from the earth, however, the air-ship would appear to be stationary.

Let the wind then slacken and drop down to a speed of 10 metres, or even to 5 metres per second. The effect of this decrease in the "head wind" will be exactly the same as if, in a calm, the motor were to move more slowly, and we should then have the same succession of phenomena as were described in the case of varied motion in a calm. The apparatus would drop, and move downward with an accelerated motion; the well-known counteracting forces would come into play and bring the machine back to its normal position, so that its course would be downward in an inclined undulating path.

When the air-ship has come back to its original level and the wind to its original velocity of 10 metres per second, then the apparatus will have, with reference to the earth, a velocity of $v_1 + f - v$, if we term v_1 its own speed, f the acceleration due to the downward movement, and v the speed of the wind; then if $f = 5$ metres, the aeroplane at this instant has a velocity of $15 + 5 - 10 = 10$ metres per second with reference to the earth. Of course this acceleration is lost as soon as the apparatus has resumed its original horizontal position.

Let us now consider the other case, and investigate what will happen if the air-ship is flying in the same direction as the wind. Let us assume again that the aeroplane is moving with its own normal velocity of 15 metres per second and in the same direction as a wind of 15 metres. The combined velocity with reference to the earth will be $15 + 15 = 30$ metres per second in the wind's direction.

Suppose, further, that the wind suddenly drops to a speed of 10 metres per second, then the effect on the machine will be the same as that above described with a wind increased in velocity, or the same as when, *in a calm*, the motor was urged so that the speed of the machine increased. In this case the "head wind" will increase, the machine will take an upward course, and its speed will then be retarded. The sequence of motions will be the same as already described, and the air-ship will move upward on a series of undulations without any increased expenditure of motive power. The difference in wind velocity is again the source of energy, but in this case it is the *diminution* of the wind's speed which acts as a source of power. When the apparatus reaches the higher level, it has a velocity relatively to the earth of $v_1 + (v - w)$, in which w is the retardation due to the upward movement If $w = 5$ metres per second, then the velocity of the machine at this instant is $15 + (10 - 5) = 20$ metres, so that the greater elevation has only been attained by using up the velocity of the apparatus.

As soon as the aeroplane, after rising, has resumed its horizontal position, the retardation ceases, and the apparatus resumes its normal velocity of 15 metres per second, without losing the elevation acquired; moving with reference to the earth with a velocity of $15 + 10 = 25$ metres per second.

Let the wind again begin to increase in velocity, rising from 10 metres to 15 metres per second, and its influence on the apparatus will be exactly the same as though the speed of the motor was decreased in a calm. The "head wind" will be less, and the machine will move downward on an inclined wavy path.

When the air-ship has come back to its lower level, and the wind's velocity has risen to 15 metres, the former will have a velocity, relatively to the earth, of $(v_1 + f) + v = (15 + 5) + 5 = 35$ metres per second, if f be termed the acceleration and equal to 5 metres per second.

We see clearly, in this case, that the apparatus has gained 5 metres per second in velocity, without any expenditure of power on the part of the motor.

While in the explanations just given I merely intended to prove that wind gusts can only affect the stability of an aeroplane machine by causing it to perform certain undulatory motions, which, when the apparatus is properly designed, will be quite flat and gentle, and will not endanger it so long as it does not touch the earth, yet I could not help touching briefly upon the natural source of energy which is at the disposal of the soaring bird, in the constantly varying velocities of the wind.

It now remains for me to consider the *lateral* wind gusts and their influence on the stability of the aeroplane.

Let us assume a uniform current of wind blowing from a to b, with a velocity of 10 metres per second, while the aeroplane is steered with a velocity of 15 metres per second in the direction $a\ a'$—that is, at an angle of 90° to the direction of the wind. In this case the air-ship, as seen from the earth, will move from a to b^1 with a velocity of $\frac{v_1}{\cos.\ \alpha}$. If, however, it is desired to have the machine reach the point a', then it must be steered in the direction $a\ d'$. It will then, as seen from the earth, move from a to a' with a velocity of $v_1 \cos.\ \alpha$.

In case the velocity is 15 metres per second, the aeroplane will have to be steered toward e'. It would then again travel, relatively to the earth, from a to a', but with a speed of $v_1 \cos.\ (\alpha + \beta)$.

In all these cases the aeroplane does not feel any lateral wind, it is flying in a calm, with merely a "head wind" of 15 metres per second, due to its own velocity.

Suppose, however, that the lateral wind current is not uniform, but has a velocity varying at every instant. Take, for instance, its mean velocity at 10 metres per second, rising at one instant of time to 15 metres and again dropping to 5 metres, and so on. In such a case the air-ship feels only a part of this change of velocity in the lateral current, and only for a very short space of time, until the apparatus has assumed its new direction.

In case the wind, while the air-ship is steered from a to d', suddenly rises from 10 metres to 15 metres per second, the machine will be struck by a "side wind" of 5 metres per second, coming from the right hand side. This current from the right will strike the vertical rudder D (fig. 2), which is attached on a long lever, far to the rear from the centre of gravity, and this will automatically direct the air-ship in the direction $a\ e'$. In case now the velocity of the wind suddenly drops to 10 metres per second, the aeroplane will again be struck by a side wind of 5 metres per second, but this time from the left-hand side, and the vertical rudder D will at once bring it back to the course $a\ d'$.

In such cases the air-ship would, of course, be subject to strong side gusts. It seems, however, quite out of the question that the wind shall ever increase suddenly from 10 metres to 15 metres per second. It will rise slowly and die away slowly, so that the vertical rudder D will begin to act at the very instant that the wind velocity changes, and will give the machine the proper direction. The aeroplane will therefore *never* be exposed to the full difference of velocity, but will only be subjected to gradual changes, which will merely force it to pursue a gently undulating line, such as $a\ d^2$.

The aviator will use the horizontal rudder c and the vertical rudder D in order to give his air-ship the desired direction and elevation during flight, as well as when starting and landing, but the maintenance of equilibrium must take place automatically without any special mechanism, and must not be dependent solely upon the skill of the aeronaut.

In order to make a landing, when flying in windy weather, the machine must be steered dead against the wind before touching the ground. It should be given a velocity, as nearly as may be possible, equal to the speed of the wind, so that it will be at rest relatively to the earth, and will drop gently downward, until it rests on the ground.

When making a landing in a dead calm, it is necessary to steer so as to give the machine a quick and strong upward glance, so as to check the velocity as much as possible, before dropping to the ground after bringing the apparatus back upon a level keel.

When resting on the earth the aeroplane is liable to be upset by every wind gust, unless it be so mounted as to turn automatically upon a pivot, like a weather vane, and thus adjust itself directly in the line of the wind. When it has risen into the air, and is immersed in this elastic medium, and has acquired a definite velocity of its own, then the wind gusts can no longer harm it. They can only force it to follow long and gentle undulatory paths, either horizontal, vertical, or a combination of the two.

For a body immersed in air, the difference between a calm and a current is, so far as the maintenance of equilibrium is concerned, by no means so great as is commonly but erroneously assumed. A ship in the stormy sea, dipping its keel into the inelastic water, while its great sails are buffeted by the wind waves, is much harder to keep in a state of equilibrium than an aeroplane entirely surrounded by an elastic medium.

I regret that, hitherto, it has been impossible for me, from pecuniary reasons, to construct a full-sized aeroplane machine, in order to prove practically that it can be kept in a condition of stable equilibrium, as easily as I have demonstrated can be done by my small-scale models.

A SIMPLE AEROPLANE.

To the Editor of AERONAUTICS :

Mr. Albert A. Merrill, of Boston, recently made some interesting experiments not far from the Blue Hill Observatory, near Boston, on August 24. The experiments were conducted in a field belonging to Mr. Hemenway, which is about a mile from the observatory. The apparatus was a two-winged aeroplane, having a total spread from wing tip to wing tip of 22 ft., and a width of 7 ft. The wings consisted of two rectangular bamboo frames of canvas connected by a continuous pole. Thus the wings were not hinged at the point in the centre where there was an opening for the body of the experi menter. The guiding movement was made by slanting upward the whole apparatus at an angle, so that when one wing extended upward the other extended downward, thus resulting in a circular flight. Mr. Merrill told me that his apparatus weighed only 21 lbs., but he said Herring's aeroplane weighed only 19 lbs. Mr. Merrill's apparatus cost only $15, and his system of using canvas covers for the frames seems admirable. By running with the outspread wings against the wind, Mr. Merrill was supported clear of the ground for a distance of 15 ft. down the incline of a steep hill. Mr. H. F. Clayton, of Blue Hill Observatory, made two flights or jumps of about the same length ; and in one instance, the aeroplanes, owing to a puff of wind, raised Mr. Clayton 4 ft. or 5 ft. above the ground, when the long rod connecting the wings broke, and Mr. Clayton dropped to the ground with the disjointed aeroplanes on top of him ; but he happily was not injured. It was the opinion of all that, had the wings not broken, Mr. Clayton might have been lifted a considerable distance by the opposing wind, which was somewhat gusty. The experiment clearly demonstrated the supporting power of the air. Among others present at the experiment besides the writer were A. Lawrence Rotch, Director of the Blue Hill Observatory, Charles S. Rackemann, and J. T. Burr, Jr., of Milton, Mass.

BAYONNE, N. J. WILLIAM A. EDDY.

NOTES.

Clearing Snow from Balloons.—In a lecture before the annual Congress of French Scientific Societies, delivered on April 18, 1895, by Mr. C. Jobert, the veteran mechanical engineer and aeronaut, he discussed the difficulties likely to be encountered by snow falling upon a balloon in Arctic explorations, and proposed a device to remedy them.

This consisted of a curved rib or semicircle of wood, pivoted at its centre upon the upper pole of the balloon, and supported at its lower ends by beams extending to a turntable placed around the gathering circle of suspension. This rotating rib is to be armed with brushes, coming into contact with the upper hemisphere of the balloon, and sweeping off the snow as it falls. The upper hemisphere is, moreover, to be protected against hail by an outer skin underlaid with cotton batting, resting upon the main skin, so as to prevent the balloon from being pierced or rent by hailstones.

The car is to be of metal, boat shaped, and to contain a motor which may either rotate the curved rib or actuate propelling screws to rise or descend, or even to drive the boat forward should it fall into the water. A supply of compressed hydrogen, to fill pilot balloons and to repair losses, is to be carried in a cylinder placed under the seats, and a water drag is provided in the shape of a bucket, which may be controlled from the car, so as to fill or empty at pleasure.

It is suggested that the balloon skin may be made impermeable by galvanic deposition of copper, nickel or aluminum upon a properly prepared cloth, or by interposition of metallic foil between two layers of the tissue. A sort of lightning-rod would then be placed on the top of the balloon, with a conducting wire to disperse possible discharges of electricity below the car.

The scheme is ingenious, and, although somewhat complicated, might be worth testing experimentally in a snowstorm.

Swedish-Norwegian Union Flag to Fly at the North Pole.—Mr. E. Sallström, living in the Argentine Republic, in sending a draft for a sum of money* to Mr. Andrée, the aeronaut who proposes to go to the North Pole in a balloon, says : "No matter how nicely the economical part of your gallant scheme may be cared for, there will always be some article of more or less importance which you will have to spare and which might be purchased for the money inclosed—for instance, a union flag, if nothing else."

* The draft was for about $1,000.

We learn that all the money required for Mr. Andrée's expedition has been obtained, and that in all probability he will make the attempt next June.

Long-Distance Signaling at Sea.—During the recent British naval manœuvres tests were made of two new systems of transmitting long-distance signals by night and day between ships at sea. The instruments used in connection with the experiments are the separate inventions of two naval officers, and in both cases it is understood the results obtained were highly satisfactory, showing a decided advance in a matter of paramount importance in carrying out steam tactics and other evolutions incidental to modern warfare afloat. It is also stated that the mast-head semaphore devised by Rear Admiral A. K. Wilson, V.C., has proved exceedingly useful for rapid and trustworthy communication with vessels within a radius of 10 miles, beyond which distance the movements of the arms could not be clearly made out. The collapsible drum, invented by Rear Admiral C. G. Fane, Admiral Superintendent of Portsmouth Dockyard, could not be manipulated quite so quickly as the semaphore, but will probably find more favor in the eyes of experts, inasmuch as signals made with it on board the *Blenheim* were accurately and easily read on board the flagship *Royal Sovereign*, 16 miles away.

Compound vs. Simple Locomotives in Argentina.—A correspondent from Buenos Ayres writes that the Rosario Railway has just received from England two large eight-wheeled engines for their day express between Buenos Ayres and Rosario. "Noticing," he says, "that they were *not* compounds, whereas all the recent engines for local service have been of the compound class (two-cylinder), I asked an official why this change, and he confirmed the opinion that I had formed as to the cause of the engines being 'simples,' and that was that the compounds when tried on the through expresses had shown but little economy, while on the local trains they had proved much more economical.

"It may be pointed out here that the economy of the compounds on local traffic is probably obtained to a great extent, when the engines are starting and working at nearly full stroke, it being possible to work them with direct steam in the receiver after they have made a half stroke.

"The compounds referred to for local traffic have 6-ft. wheels, and therefore lag considerably in starting, and are worked with a long period of admission for some time. The new engines have 18 × 24 in. cylinders, 6 ft. 6 in. driving-wheels, Belpaire fire-boxes, and straight boilers of a larger diameter than any other passenger engine boilers that I have seen in this country.

"WILLIAM V. BURT."

Mortality of Telegraph Operators.—Evidence was recently given before a committee of inquiry, which the *British Medical Journal* accepts with a very slight reservation, to the effect that half the telegraphists who die between 15 and 55 years are victims to disease of the respiratory organs, while the general public at the same ages suffers only in the proportion of 24 per cent. No explanation of this fact, if it be a fact, is suggested. May it not be that the cause is due to operators inhaling the fumes from batteries which are in close proximity to the places where they work ?

Clocks on Locomotives.—The Paris-Lyons-Mediterranean Railway Company has recently fixed clocks on the outside of its locomotives, on the side toward the station platforms, in order that passengers can observe the time and that the station officials can more conveniently note the exact time of arrival and departure. In spite of the great vibration, the clocks are said to show no variation.

Compound Locomotives in Germany.—As tending to show the extent to which compound locomotives are being introduced in Germany, it is reported that toward the end of last year the Directors of the Prussian State Railways decided, after exhaustive trials, to use compound locomotives for all through freight and express services, but not for suburban services or for trains requiring to make any stoppages. In order to carry this decision into effect, orders have been given for the construction of 167 compound locomotives to be supplied during the current year.

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